Final Environmental Indicators (EI) Report

Millennium Petrochemicals, Inc.
ILD005078126 – Douglas County – 0418080002

Equistar Chemicals, LP – Tuscola Plant
625 East US Hwy 35 / Tuscola, Illinois

Volume 1 of 4
Text, Figures, Graphs, and Tables

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Prepared for:
MILLENNIUM PETROCHEMICALS, INC.
Cincinnati, Ohio

Prepared by:
CLAYTON GROUP SERVICES, INC.
3140 Finley Road
Downers Grove, Illinois 60515
630.795.3200

Clayton℠
GROUP SERVICES

FINAL ENVIRONMENTAL INDICATORS (EI) REPORT

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LIST OF ACRONYMS AND ABBREVIATIONS

Agreement	Voluntary Corrective Action Agreement
AOC	Area of Concern
AST	aboveground storage tank
atm m^3/mol	Atmospheres cubic meter per mole
bgs	below ground surface
BOD	Biological Oxygen Demand
BSC	Biological Stream Characterization
C	Coefficient of conservatism
$\bar{C}$	Mean C Value
cfs	cubic feet per second
Clayton	Clayton Group Services, Inc.
COD	Chemical Oxygen Demand
DNAPL	Dense Non-Aqueous Phase Liquid
EDQL	Ecological Data Quality Levels
EI	Environmental Indicator
Equistar	Equistar Chemicals, LP
F	Fahrenheit
FOC	Fraction of organic carbon (non-volatile)
FQA	Floristic Quality Assessment
FQI	Floristic Quality Index
GPS	Global Positioning System
HRS	Hazard Ranking System
Illinois DNR	Illinois Department of Natural Resources
Illinois EPA	Illinois Environmental Protection Agency
Illinois NAI	Illinois Natural Area Inventory
Illinois PCB	Illinois Pollution Control Board
Illinois SGS	Illinois State Geological Survey
Illinois SWS	Illinois State Water Survey
ID	Inside diameter
IWSC	Illinois Water Supply Company
K_{OC}	Organic carbon partition coefficient
K_{OW}	Octanol/water partition coefficient
LNAPL	Light Non-Aqueous Phase Liquid
mgpd	million gallons per day
Millennium	Millennium Petrochemicals, Inc.
mph	miles per hour
msl	Mean sea level
N	Number of native species
NCDC	National Climatic Data Center
NEDIS	National Environmental Satellite Data and Information Service

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

NHD	Natural Heritage Database
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated biphenyl
pcf	Pounds per cubic foot
PEMAf	Palustrine System – Emergent Wetland Class
PFO1C	Palustrine System – Forested Wetland Class
PID	Photoionization Detector
ppm	Parts per million
PQL	Practical Quantitation Limits
PUBFh	Palustrine System – Unconsolidated Bottom Class
PVC	Polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
SOP	Standard Operating Procedure
SVOC	Semi-Volatile Organic Compound
SWMU	Solid Waste Management Unit
TACO	Tiered Approach to Corrective Action Objectives
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TSS	Total Suspended Solids
µg/kg	Micrograms per kilogram
µg/L	Micrograms per liter
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
USDA	United States Department of Agriculture
USDC	United States Department of Commerce
USEPA	United States Environmental Protection Agency
USFEMA	United States Federal Emergency Management Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VOC	Volatile organic compound
WWTP	Wastewater Treatment Pond

EXECUTIVE SUMMARY

Millennium Petrochemicals, Inc. (Millennium) is conducting a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) at its former facility in Tuscola, Illinois. This is being done as part of the Voluntary Corrective Action Agreement (Agreement) between the United States Environmental Protection Agency (USEPA) and Millennium, dated September 29, 2000. The facility is located approximately 4 miles west of Tuscola, Illinois and is presently operated by Equistar Chemicals, LP.

The purpose of the RFI is to identify the nature and extent of releases of hazardous waste and/or hazardous constituents from solid waste management units (SWMUs), or areas of concern (AOCs) identified by the USEPA (1988) that may pose an unacceptable risk to human health or the environment. The study area for this RFI encompasses the area within a 2-mile radius of the center of the facility.

National Distilleries and Chemicals Corporation, under the name U.S. Industrial Chemicals Company, developed the site as a chemical manufacturing facility producing a variety of organic and inorganic chemicals in 1952. Ethane, propane, butane, and other natural gas constituents have been extracted and liquefied or used to produce petrochemicals. Nitric, phosphoric, and sulfuric acids were also formerly manufactured at the facility. Presently, the facility manufactures ethyl alcohol, diethyl ether, and powdered polyethylene along with a line of compounded products for wire and cable jacketing and insulation. The facility changed its name to Quantum Chemical Corporation in the late-1980s and, subsequently, Millennium Petrochemicals, Inc. in the mid-1990s. In December 1997, Millennium transferred certain assets, including the Tuscola, Illinois facility, to Equistar Chemicals, LP.

The USEPA conducted a RCRA Facility Assessment (RFA) in 1988 and identified the following SWMUs:

- Wastewater treatment ponds (WWTPs)
- Surface water impoundment (Snake River)
- Offsite drainage from the southwest area of the site
- Temporary holding pond (Pit 11) associated with the wastewater treatment system
- Fly ash/acid pit landfills and gypsum piles

All of these SWMUs are currently closed with the exceptions of the WWTPs and the offsite drainage in the southwest portion of the site.

The Snake River surface water impoundment, formerly in the southwest portion of the facility, was certified clean closed by the Illinois Environmental Protection Agency (Illinois EPA) in 1997. There were no known groundwater exceedences from the impoundment prior to termination of post closure groundwater monitoring. Seven fly ash/acid pit and gypsum landfill areas were capped and certified closed by the Illinois EPA on December 6, 1994. The temporary holding pond, Pit 11, was also incorporated into the landfill closure. An Illinois EPA-permitted landfill post-closure groundwater monitoring program is currently in place.

The WWTPs, 24 unlined lagoons in the northwest portion of the facility, are used for industrial and sanitary wastewater treatment, and storm water management. The WWTPs are grouped into designations identified as high, middle, and low ponds. Treated wastewater is discharged from the WWTPs into the adjoining Kaskaskia River under an Illinois EPA-issued National Pollutant Discharge Elimination System (NPDES) permit.

The offsite drainage consists of an intermittent stream that originates in the southwest area of the site. It flows, in a general westerly direction, into an offsite unnamed pond before eventually discharging to the Kaskaskia River.

The primary RFI activities within the study area included:

- A subsurface investigation and testing to characterize the geologic and hydrogeologic characteristics of the WWTP location and the facility background area. This included installation of nine nested (two per nest) wells (seven well nests surrounding the WWTP area, one well nest south of the facility, and one well nest east of the facility); one shallow monitoring well at the WWTP area; and one deep monitoring well immediately east of landfill area #2.

- Sampling of source media, specifically, sediment and sludge, from the active SWMUs (the WWTPs and the intermittent stream).

- Sampling of media potentially affected by the SWMUs, specifically, Kaskaskia River surface water and sediment; including, the inlet and outlet channels from the river to the facility and groundwater (three rounds) from the RFI monitoring wells.

- Analysis of the various media for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), metals, and other major cations and anions. The results were compared to screening levels, established for the facility as part of the Agreement, to identify potential contaminants of concern.

- An ecological inventory, including wetlands delineation and a potable well survey.

Based on the information obtained during the RFI, the following findings are presented:

- The study area geology consists of pre-Illinoian, Illinoian, Sangamonian, and Wisconsinan stage glacial drift. Five lithologic units were determined: an upper glacial till, an interglacial layer, a middle glacial till, a sand aquifer, and a lower glacial till. The upper glacial till, a silty clay with some sand and gravel, was deposited during the Wisconsinan Stage. The underlying interglacial layer, characterized by silts, organic silts, sand, and peat, was deposited during the Wisconsinan and Sangamonian Stage. The underlying middle glacial till consists of Illinoian stage silty clays and clayey silts with lenses of sand and gravel. Underlying the middle till is an Illinoian age confined sand aquifer characterized by alternating layers of poorly sorted and well sorted sand. The lower glacial till, deposited during the pre-Illinoian Stage, underlies the aquifer, and consists of gray silty clays with low moisture.

- The hydrogeology of the study area is divided into two hydrostratigraphic units identified as the shallow glacial drift pathway and the deep glacial drift pathway. The shallow glacial drift pathway is defined as groundwater within the upper glacial till. The deep glacial drift pathway is defined as groundwater within the interglacial, the middle glacial till, the sand aquifer, and the lower glacial till. The shallow glacial drift pathway has been classified as Class II groundwater during the course of the Illinois EPA landfill post closure groundwater monitoring program. The deep glacial drift pathway is considered Class I groundwater.

- The average hydraulic conductivity of the shallow glacial drift pathway is 1.03E-03 cm/sec, and the geometric mean is 6.93E-05 cm/sec. The average hydraulic conductivity of the deep glacial drift pathway is 7.56E-02 cm/sec, and the geometric mean is 8.95E-03 cm/sec.

- The shallow glacial drift pathway is affected by a generally north-south groundwater divide located on the east side of the site at the landfills. Groundwater west of the divide flows west and discharges into the Kaskaskia River. Groundwater east of the divide flows east into the Embarras River drainage system. Due to the mounding affect of the landfills, there is also a component of flow to the north of the landfills. The groundwater divide does not appear to extend to the deep glacial drift pathway. The flow in the deep glacial drift pathway is to the west toward the Kaskaskia River.

- The ecological inventory indicated four wetland types located within the study area: three Palustrine System wetlands (specifically Emergent, Unconsolidated Bottom, and Forested Classes) and one Lacustrine System wetland (designated Limnetic Subsystem with a Class of Unconsolidated Bottom). The wetlands contained a diversity of flora and fauna with no observable signs of deteriorated or stressed ecosystems. A diverse group of aquatic life was also identified in the Kaskaskia River and its tributaries. The Illinois Department of Natural Resources (Illinois DNR) has identified a reach of the Kaskaskia River, including the portion within the study area, as a natural area due to high mussel diversity. One Illinois endangered mussel species and one Illinois threatened mussel species have been identified by the Illinois DNR in this area. Forty (40) potable wells have been identified within the study area with the nearest residential well located less than 700 feet from the facility. The majority of these wells appear to be screened in a confined sand aquifer at a depth of 100 feet or less.

- Analyses of samples were compared to screening levels specified by various regulatory bodies intended to be protective of either human health or ecological receptors (flora and non-human fauna). A detection of a contaminant above a screening level does not indicate a risk to human health or the environment. It only indicates the need for additional analyses.

- *WWTP Sludge Sampling*: Four VOCs, six SVOCs, and three metals were identified in the analyses of the WWTP source media, specifically the sludge, as potential contaminants of concern. Three VOCs (ethylbenzene, toluene, and tetrachloroethene) exceeded screening levels only in the high ponds, while benzene exceeded screening levels in the high, middle, and low ponds. Three SVOCs (benzo[a]anthracene, benzo[a]pyrene, and benzo[b]fluoranthene) were detected above screening levels in all of the ponds. Two SVOCs (dibenzo[a,h]anthracene and indeno[1,2,3-cd]pyrene) were detected over screening levels in the high and middle ponds. One SVOC (naphthalene) was detected above screening levels only in the high ponds. Three metals (arsenic, beryllium, and total chromium) were found above their respective screening levels throughout all of the ponds. The benzene and metals concentrations progressively decreased from the high to the low ponds.

- *Kaskaskia River Surface Water Sampling*: No contaminants exceed any human health based screening levels for surface water. However; two (2) SVOCs (anthracene and pyrene), exceeding ecological screening levels, were detected in a water sample collected from the Kaskaskia River at the railroad bridge downstream of the facility. These contaminants are commonly associated with the preservatives in railroad ties; and therefore, may be attributable to leaching of the contaminants from the ties into the river. Furthermore, these contaminants were not detected in any of the surface water samples collected upstream of this location including the sample collected between the bridge and the facility and the sample collected from the wastewater treatment ponds outlet channel. Therefore, these contaminants are not considered as surface water contaminants of concern attributable to the facility.

- *Kaskaskia River and inlet/outlet channel Sediment Sampling*: Two (2) VOCs (acetone and ethylbenzene); PAHs; and six (6) metals (arsenic, cadmium, chromium, copper, nickel, and zinc) have been identified as potential contaminants of concern in sediment samples collected from the facility outlet channel and downstream of the facility due to concentrations exceeding ecological screening levels.

- *Intermittent Stream Sediment Sampling*: The PAHs; four (4) metals (arsenic, chromium, copper, and nickel); and cyanide have been identified as potential contaminants of concern in onsite sediment samples collected from the intermittent stream. These contaminants were not detected in the sediment sample collected from the offsite pond, which receives flow from the intermittent stream due to concentrations exceeding ecological screening levels. Furthermore, the detected levels of the PAHs, metals, and cyanide progressively decrease in concentration downstream of the head of the intermittent stream.

- *VOCs in Groundwater Sampling*: The shallow glacial drift pathway is identified as Class II groundwater and the deep glacial drift pathway is classified as Class I groundwater (as discussed above). Three (3) VOCs (benzene, cis-1,2-dichloroethene, and vinyl chloride) were detected above Class II groundwater screening levels at a single location (MW03S) in the shallow glacial drift pathway. Thus, the 3 VOCs were identified as potential contaminants of concern. None of these VOCs was detected in the remaining RFI samples above Class I screening levels in the deep glacial drift pathway or above Class II screening levels in the shallow glacial drift pathway. In addition, none of the VOCs was detected in MW10 (screened in the shallow glacial drift pathway) only about 200 feet southwest of MW03S. This indicates the VOC impacts at MW03S are of limited extent and confined to the site. Chloroform, originally detected in several of the groundwater samples from the deep glacial drift pathway, was introduced by drilling water during the completion of the soil borings for the installation of the monitoring wells and is not a contaminant of concern.

- *SVOCs in Groundwater Sampling*: The only SVOCs detected in the RFI groundwater analyses were PAHs in a groundwater sample collected from MW04S (shallow glacial drift pathway) during the March 2001 sampling event, and in a groundwater sample collected from MW01S (deep glacial drift pathway) during the August 2001 sampling event. The concentrations of the PAHs detected in MW04S were below their respective Class II groundwater screening levels, and therefore; are not potential contaminants of concern. The PAHs detected in MW01S are the likely result of cross-contamination from vapors coming from the recent road oiling of the county road beside MW01S.

- *Metals in Groundwater Sampling*: Four metals (boron, iron, lead, and manganese) were identified as potential contaminants of concern in the groundwater. None of the groundwater analyses conducted during the RFI detected boron above its Class I or Class II screening levels in the shallow or deep glacial drift pathways. However, boron historically has been detected in the onsite landfill monitoring wells, which are in the shallow glacial drift pathway, at concentrations above Class II screening levels. Iron was detected in the shallow glacial drift pathway above its Class II screening level and in only three (3) RFI monitoring wells screened in the deep glacial drift pathway on a repeatable basis above its Class I screening levels in the RFI analyses. Lead was only detected in two RFI monitoring wells (MW04D – March 2001 sampling event and MW06S – August 2001 sampling event) within the deep glacial drift pathway above its Class I screening level. No lead concentrations were detected in the shallow glacial drift pathway above Class II screening levels in any of the RFI groundwater analyses. Historically, iron and lead have also been identified above their respective Class II screening levels in the onsite landfill monitoring wells located in the shallow glacial drift pathway. Manganese was detected in only four (4)

RFI monitoring wells within the deep glacial drift pathway on a repeatable basis above its Class I groundwater screening level. However, it was not detected in any RFI groundwater analyses from the shallow glacial drift pathway above the Class II groundwater screening level. The concentrations of boron, iron, lead, and manganese detected in the deep glacial drift pathway appear to be consistent with regional concentration levels based on the results of the potable water well sampling. Therefore, these metals have been identified as potential contaminants of concern with respect to the shallow glacial drift pathway, which is not used for human consumption.

- *Other Inorganics in Groundwater Sampling*: The groundwater also contains three inorganic analytes (chloride, sulfate, and total dissolved solids [TDS]) identified as potential contaminants of concern. Chloride was detected in the shallow glacial drift pathway at concentrations above its Class II screening level in only one RFI well (MW03S) during the RFI sampling events. Historically, it has also been detected in existing landfill monitoring wells within the shallow glacial drift pathway above its Class II screening level. Sulfate was found in the shallow glacial drift pathways, during the RFI, at concentrations above its Class II screening level. Historically, sulfate has also been detected in several of the existing landfill monitoring wells within the shallow glacial drift pathway above its Class II screening levels. Sulfate was also found at concentrations above its Class I screening level in one (1) RFI monitoring well (MW01S) screened in the deep glacial drift pathway. Sulfate was not detected above its Class I screening level in any of the potable water well samples. No screening levels exist for TDS; however, concentrations of TDS in the shallow glacial drift pathway, identified in the RFI, exceed the Groundwater Quality Standard (GQS) in 35 Illinois Administrative Code (IAC) Part 620. Historically, TDS has also exceeded the Groundwater Quality Standard in the landfill monitoring wells in the shallow glacial drift pathway. TDS was also detected at concentrations above its GQS in one (1) RFI monitoring well (MW09D) during only one (1) of the three sampling events. Therefore, these other inorganics have been identified as potential contaminants of concern with respect to the shallow glacial drift pathway, which is not used for human consumption.

Based on the data collected during the RFI activities, the following conclusions have been made:

- The nature of the WWTP source media, specifically the sludge, has been characterized. The characterization has identified 13 potential contaminants of concern in the sludge. The contaminants include four VOCs, six SVOCs, and three metals.

- It is unlikely that site operations have impacted the Kaskaskia River surface water or the ecology and wetlands associated with it.

- The sediment samples from the river and the intermittent stream originating in the southwest area of the facility contain VOCs, SVOCs, and metals above screening levels. The concentrations found in the impacted areas do not warrant interim corrective action. The need for corrective action will be evaluated during the Corrective Measures Study.

- Impacts to groundwater within the shallow glacial drift pathway center around the area of the wastewater treatment plant (MW03S) and the landfills. No contaminants of concern are present in monitoring well MW10 (located approximately 200 feet southwest of MW03S and 200 feet north of the facility's southern border). Therefore, the impacts appear to be localized and contained on site. The need for corrective action in this area will be evaluated during the Corrective Measures Study. The impacts associated with the landfills are already being addressed as part of the Illinois EPA post-closure permit. The Illinois EPA has required a landfill groundwater assessment monitoring program, which the facility is implementing. This assessment program will determine if corrective action is needed with respect to the groundwater impacts from the landfill.

- The RCRA Facility Investigation demonstrates that current human exposures are under control. Furthermore, given the existence of a groundwater monitoring and assessment program that is being regulated by the Illinois EPA, the migration of contaminated groundwater is also under control. Because contaminants of concern possibly attributable to facility operations are present in stream sediments above ecological screening levels, further evaluation of this will be required.

1.0 INTRODUCTION

Clayton Group Services, Inc. (Clayton) was retained by Millennium Petrochemicals, Inc. (Millennium) to perform a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) for the former Millennium facility in Tuscola, Illinois. The facility is currently operated by Equistar Chemicals, LP (Equistar). The RFI is being done as part of the Voluntary Corrective Action Agreement (Agreement) between the United States Environmental Protection Agency (USEPA) and Millennium, dated September 29, 2000.

1.1 PURPOSE OF REPORT

The purpose of the RFI is to identify the nature and extent of releases of hazardous waste and/or hazardous constituents from solid waste management units (SWMUs), or areas of concern (AOCs) at the facility that may pose an unacceptable risk to human health or the environment. The report also provides documentation relating to the Environmental Indicator (EI) determinations as required by the Agreement. The completed EI forms are provided in Appendix A. The Current Human Exposures Under Control form (CA725) is provided in Appendix A-1, and the Migration of Contaminated Groundwater Under Control form (CA750) is provided in Appendix A-2.

1.2 SITE BACKGROUND

1.2.1 Site Description

The facility is located approximately 4 miles west of Tuscola, Illinois in Douglas County. It is located within Sections 30 and 31, Township 16 North, Range 8 East, and Section 36 Township 16 North, Range 7 East in Tuscola Township and Garrett Township, respectively. Figure 1 shows the location of the facility (the site).

The facility is bordered to the west by the Kaskaskia River and agricultural land, and to the north by agricultural land. U.S. Highway 36, a pipeline compressor station, and agricultural land are located south of the facility. Cabot Corporation and agricultural land are located east of the facility. The RFI study area is shown in Figure 1.

The facility consists of manufacturing and production areas and administrative office buildings. In addition, the following are located on the facility and are shown in Figure 2:

- Two freshwater lakes, identified as the Freshwater Lake and the North Plant Lake.
- An area of 24 wastewater treatment ponds (WWTPs) consisting of a series of unlined lagoons used for industrial and sanitary wastewater and storm water treatment. The WWTPs are divided into the high ponds, middle ponds, and low ponds (Figure 3). The facility discharges wastewater from the WWTPs into the Kaskaskia River under an Illinois Environmental Protection Agency (Illinois EPA)-issued National Pollutant Discharge Elimination System (NPDES) permit (permit number IL0000141).
- Seven fly ash/acid pit and gypsum landfill areas that were capped and certified closed by the Illinois EPA on December 6, 1994. A post-closure groundwater monitoring program was established as part of the Illinois EPA landfill closure permit (permit number 1993-004-DE/OP, supplemental permit number 1993-445-SP).
- A deep injection disposal well with an associated storage pond. This well is permitted by the Illinois EPA for the disposal of nonhazardous liquids (permit number UIC-006-W1-US).

1.2.2 Site History

The facility was originally developed in 1952 by National Distilleries and Chemicals Corporation under the name U.S. Industrial Chemicals Company. It was developed as a chemical manufacturing facility producing a variety of organic and inorganic chemicals. Ethane, propane, butane, and other natural gas constituents have been extracted and liquefied or used to make petrochemicals at the facility. Nitric, phosphoric, and sulfuric acids were also produced at one time. Presently; ethyl alcohol, diethyl ether, and powdered polyethylene are being produced at the facility. The facility also produces a line of compounded products for wire and cable jacketing and insulation. In this process, carbon black and other additives are encapsulated in plastic resins, such as polyethylene. The facility changed its name to Quantum Chemical Corporation in the late-1980s and changed its name again to Millennium Petrochemicals, Inc. in the mid-1990s. In December 1997, Millennium transferred certain assets, including the Tuscola, Illinois facility, to Equistar Chemicals, LP.

1.2.3 Previous Investigations

A "RCRA Monitoring Plan" was developed for the facility in 1981 by Bruce S. Yare and Associates, Incorporated (Yare 1981). Two groundwater monitoring wells from this investigation (OW-5 and OW-7) remain and are now identified as G116 and G117 under the Illinois EPA-permitted landfill post-closure groundwater monitoring program.

In 1988, a RCRA Facility Assessment (RFA) prepared by the USEPA identified the following SWMUs: the WWTPs; a surface water impoundment (Snake River); offsite drainage from the southwest portion of the facility; a temporary holding pond (Pit 11) associated with the wastewater treatment system; fly ash/acid pit landfills; and gypsum piles (USEPA 1988). In addition, the facility had accumulated wastes generated from alcohol and polyethylene production (ceased in 1994) for less than 90 days in aboveground storage tanks (ASTs). The tanks were decommissioned and removed in 1993. The facility demonstrated, using the Tiered Approach to Corrective Action Objectives (TACO) in accordance with 35 Illinois Administrative Code Part 742, that no further remediation was required for this area and the demonstration was approved by the Illinois EPA in 1999. The area of the ASTs is now considered closed.

A plan to close the Snake River surface water impoundment was approved by the Illinois EPA in 1993 (Weston 1993). Clean closure was certified by the Illinois EPA in 1997. There were no known groundwater exceedences prior to termination of post-closure groundwater monitoring of the impoundment.

The fly ash/acid pit landfills and gypsum piles, including the temporary holding pond (Pit 11), were capped and certified closed. The Illinois EPA issued a "Certification of Closure" on December 6, 1994 (Illinois EPA 1994). A post-closure groundwater monitoring program was established as part of the landfill closure permit. Concentration levels of inorganic constituents (including boron, iron, lead, chloride, sulfate, total dissolved solids, and pH) have been detected above permit established levels during the landfill groundwater monitoring activities. Additional groundwater monitoring wells have been installed around these landfill areas as part of an ongoing groundwater assessment program.

In summary, all of the SWMUs originally identified by the USEPA in the 1988 RFA have been closed with the exception of the WWTPs and the offsite drainage from the southwest portion of the site.

1.3 REPORT ORGANIZATION

The EI Report consists of descriptions of the site investigation, physical characteristics of the site and surrounding area, the nature and extent of contamination, and a discussion of migration pathways of the contaminants found. Summaries of the pertinent data are included.

2.0 SITE INVESTIGATION

The RFI focused on the remaining SWMUs or AOCs identified in the USEPA's (1988) RFA (see Section 1.2.3). These SWMUs consist of the WWTPs and the offsite drainage from the southwest portion of the facility. The site investigation was designed to identify the nature and extent of releases from these SWMUs that may pose an unacceptable risk to human health or the environment. In addition, the results of the ongoing landfill groundwater monitoring program have been evaluated.

The RFI activities were composed of the following investigation events: the Geologic Investigation; the Source Area Media Investigation; the Surface Water and Sediment Investigation; the Round 1, Round 2, and Round 3 Groundwater Sampling Events; the Hydraulic Characterization Investigation; the Ecological Inventory; and the Potable Water Well Sampling Event. Photographs taken during the RFI field activities are provided in Appendix B. Initial field activities were conducted between October 31, 2000 and May 2, 2001. After reviewing the results of the initial field activities, it was determined that further assessment was needed regarding the river sediments and the groundwater. The scope of work for this additional assessment is provided in Appendix N. The field activities for this additional assessment were conducted between July 9 and September 7, 2001. A brief summary of the RFI activities conducted is provided below.

The Geologic Investigation *(October 31, 2000 – July 12, 2001)*

- Sampling of soil at eleven locations (eight surrounding the WWTPs and three background locations: one south and one east of the facility and one immediately east of landfill area #2).
- Installation of nine nested (two per nest) groundwater monitoring wells (seven well nests surrounding the WWTP area, one background well nest south of the facility, and

one background well nest east of the facility), one shallow monitoring well at the WWTP area, and one deep monitoring well immediately east of landfill area #2.

- Development of the RFI monitoring wells.

The Source Area Media Investigation *(November 14, 2000 – November 29, 2000)*

- Sampling (grab) and analysis of sludge from the 24 WWTPs. Two samples were taken from each pond.

The Surface Water and Sediment Investigation *(November 1, 2000 – July 12, 2001)*

- Sampling (grab) and analysis of surface water and sediment from the Kaskaskia River (upstream and downstream of the facility) and at the inlet and the outlet channels to the facility.

- Additional sampling (grab) and analysis of sediment from the Kaskaskia River (near the Baltimore and Ohio Railroad bridge) and from the outlet channel at the facility.

- Installed staff gauges in the Kaskaskia River (4), WWTPs (7), the Freshwater Lake (1), and the North Plant Lake (1).

- Sampling (grab) and analysis of the sediment in the intermittent stream extending offsite to the west-southwest.

Round 1 Groundwater Sampling Event *(December 4, 2000 – December 13, 2000)*

- Sampling and analysis of groundwater from each of the RFI monitoring wells.

- Determined groundwater elevations from the RFI and the landfill monitoring wells, and surface water elevations from the staff gauge locations.

Round 2 Groundwater Sampling Event *(March 5, 2001 – March 9, 2001)*

- Sampling and analysis of groundwater from each of the RFI monitoring wells.

- Determined groundwater elevations from the RFI and the landfill monitoring wells, and surface water elevations from the staff gauge locations.

Round 3 Groundwater Sampling Event *(August 6, 2001 – August 11, 2001)*

- Sampling and analysis of groundwater from each of the RFI monitoring wells.
- Determined groundwater elevations from the RFI and the landfill monitoring wells, and surface water elevations from the staff gauge locations.

Hydraulic Characterization Investigation *(January 30, 2001 – July 25, 2001)*

- Conducted in situ hydraulic conductivity tests on the RFI monitoring wells.

Ecological Inventory *(April 23, 2001 – May 2, 2001)*

- Conducted an ecological field survey within an approximate 2-mile radius of the center of the site.
- Conducted a wetland delineation.

Potable Water Well Sampling Event *(September 6, 2001 – September 7, 2001)*

- Sampling and analysis of groundwater from eleven offsite potable wells surrounding the facility.

Water level measurements were conducted at the RFI and the landfill monitoring wells and the staff gauge locations in December 2000, January, February, March, April, June, July, August, and October 2001.

A list of parameters and practical quantitation limits for each analyzed medium is presented in Tables 1, 2, and 3. Pesticides are not associated with any of the past or present processes at the facility; therefore, no pesticide analyses were conducted.

Chemical analysis samples (with one exception) were submitted to Clayton Group Services Laboratory of Novi, Michigan. Due to the limited analytical method holding times for hexavalent chromium and nitrates, Simalabs International of Merrillville, Indiana was used for the analysis of these parameters. Soil analysis for physical parameters was performed by Great Lakes Analytical of Buffalo Grove, Illinois, Clayton Laboratory, and IAS Laboratory in Phoenix, Arizona. The standard operating procedures (SOP) for sampling and other field activities are provided in Appendix L.

2.1 SOURCE AREA MEDIA INVESTIGATION

The source area media investigation involved sampling and analysis of the sludge from the 24 WWTPs. Two (grab) sludge samples were collected from each pond for a total of 48 samples. The WWTPs were accessed by walking or using a fishing boat with an electric motor. Samples were collected using a decontaminated stainless steel hand auger and metal spoon. The sludge was collected in laboratory-supplied 4-oz. and 8-oz. glass jars, with the following exception. If the sludge was solidified, volatile organic compounds (VOC) samples were collected using the USEPA's SW-846, 5035 field preparation method. A SOP for sludge sampling is included in Appendix L-2. The sample locations were determined by differential global positioning system (GPS) equipment and are shown in Figure 3. The sludge samples were analyzed for VOCs, semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), metals, other major cations and anions, and pH.

2.2 METEOROLOGICAL SURVEY

A meteorological survey was conducted and consisted of obtaining temperature, precipitation, and wind data for the vicinity of the study area. Meteorological data was obtained from the *Climatic Atlas of the United States* (NOAA 1983), *Climatic Wind Data for the United States-Summary* (NCDC 1998), and the *Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days 1961-1990-Illinois* (USDC 1991). Additional wind data was collected from the Illinois State Climatologist Office.

Climatic wind data was based on data collected at the Springfield/Capital Airport weather station in Springfield, Illinois (approximately 100 miles west of the study site). The period of record for the wind data summary is between the years of 1930 and 1996.

Temperature and precipitation information was collected at the Tuscola, Illinois weather station (station number 11-8684, located approximately 4 miles east of the site) during the years of 1961 to 1990.

2.3 GEOLOGICAL INVESTIGATION

The geological investigation consisted of the advancement of soil borings at eleven locations for stratigraphic data. Soil borings were advanced using Rotosonic drilling procedures. Rotosonic drilling technology consists of advancing a 4-inch sampling core barrel and a 6-inch outer casing, if needed, using rotation and vibration. The borings were sampled continuously to termination. Potable water (obtained from the facility) was added to the borings to facilitate drilling operations, as necessary, due to the "hard" nature of the material. The volume of drilling water not recovered during drilling operations was estimated and subsequently removed during monitoring well development. Nested wells (one shallow and one deep) were installed at nine of the locations. Additionally, a single deep monitoring well and a single shallow monitoring well were installed. Figure 2 shows the RFI and landfill monitoring well locations.

2.3.1 Monitoring Well Installation and Development

The ten deep wells (MW01D-MW09D, and MW11) were installed to depths ranging from 71 to 104 feet below ground surface (bgs) within a confined sand aquifer, within the glacial drift. Seven shallow monitoring wells bgs (MW02S, MW03S, MW04S, MW05S, MW08S, MW09S, and MW10) were installed to depths ranging from 14 to 25 feet, and three wells (MW01S, MW06S, and MW07S) were installed to depths ranging from 35 to 55 feet bgs into the glacial drift. A monitoring well installation SOP is included in Appendix L-3.

Monitoring wells were constructed using 2-inch inside diameter (ID) 304 stainless steel riser and 2-inch ID 0.010-inch slotted stainless steel screen. RFI monitoring well installation and construction details are provided in Table 4. The monitoring well soil boring logs, well completion diagrams, and well construction diagrams are found in Appendix C-1, C-2, and C-3, respectively.

Monitoring wells were allowed to set a minimum of 24 hours after installation prior to development. Development was performed using a submersible pump or bailer. Development was performed (after removal of the estimated volume of water introduced during drilling) until pH, conductivity, temperature, and turbidity stabilized or the wells were pumped dry and allowed to recharge at least three times. A well development SOP is included in Appendix L-4. Summarized well development indicator parameters are included in Table 5.

In early December 2000, monitoring wells MW08D and MW08S were struck by an unknown vehicle. The concrete pads, protective casings, and the well casings were damaged. The well casing was bent at approximately 3.5 feet bgs at monitoring well MW08D and at 3.1 feet bgs at MW08S. The wells were repaired by digging below where the well casing was bent and cutting off the damaged riser. Lengths of 2-inch ID polyvinyl chloride (PVC) casing were connected to the stainless steel risers, with couplings secured by hose clamps to extend the top of the wells to ground surface. The monitoring wells were finished flush with the ground surface.

The monitoring wells were surveyed for northing and easting coordinates after completion by Illini Engineering Associates of Mattoon, Illinois. Additionally, the elevations above mean sea level (msl) were obtained for the top of each well casing and the ground surface.

2.3.2 Glacial Till Soil Sampling

Continuous soil sampling was conducted at each of the RFI monitoring well locations. Borings were logged by a Clayton geologist using the Unified Soil Classification System (USCS). In addition, olfactory observations were noted along with sample recovery, moisture content, and photoionization detector (PID) scan readings. The PID, equipped with a 10.2 electron volt (eV) probe and calibrated to an isobutylene standard, measures total concentrations of organic vapors. The PID cannot identify or quantify specific components. A SOP for borehole logging and material classification is included in Appendix L-5.

Four soil samples were collected and stored in laboratory-supplied 8-oz. glass jars for physical analysis from each of four soil borings (SB01/MW01D, SB04/MW04D, SB06/MW06D, and SB11/MW11). The location of the borings is shown in Figure 2.

Soil samples were collected from an unsaturated silty clay (collection depths ranging from 5 to 25 feet bgs), a saturated silt (collected from 35.5 to 69 feet bgs), an unsaturated silty clay (collected from 42 to 85 feet bgs), and a saturated sand (collected at 66 to 101 feet bgs). The soil samples were submitted for analysis to Clayton Laboratory, Great Lakes Analytical, and IAS Laboratory. The soil samples were analyzed for grain size, soil, pH, and moisture. Those samples collected from unsaturated silty clay units were analyzed for total organic carbon (TOC), and those samples collected from saturated silt or saturated sand were analyzed for non-volatile fraction of organic carbon (FOC), non-carbonate method. The samples were also analyzed for bulk density with eight exceptions. Analysis for bulk density could not be performed on those eight samples due to the samples' disturbed condition.

2.4 GROUNDWATER INVESTIGATION

The groundwater investigation consisted of three rounds of groundwater sampling of the RFI monitoring wells, collection of water samples from selected potable water supply wells, and the hydraulic characterization of the glacial deposits. In addition, nine rounds of water elevations were determined from the RFI and the landfill monitoring wells.

2.4.1 Groundwater Sampling

The sampling of the RFI groundwater monitoring wells and the selected potable water supply wells is discussed below.

2.4.1.1 RFI Monitoring Well Sampling

Groundwater samples were collected from the RFI monitoring wells (MW01D/MW01S through MW09D/MW09S) during the first two sampling events. The third groundwater sampling event included RFI monitoring wells MW01D/MW01S through MW11. The first round of sampling was conducted during the first two weeks of December 2000. The second round of sampling was conducted during the first week of March 2001. The third round of sampling was conducted during the first week of August 2001. The monitoring well locations are included in Figure 2. Groundwater samples were collected from all 18 of the initially installed RFI monitoring wells during the first two rounds of sampling. Groundwater samples were collected from the 18 original RFI monitoring wells and the two monitoring wells installed in July of 2001 during the third round. A SOP for groundwater sampling is included in Appendix L-6.

The shallow RFI monitoring wells (MW01S-MW09S and MW10) were purged with a peristaltic pump until a minimum of three well volumes were removed. Purging continued until groundwater indicator parameters (i.e., pH, conductivity, temperature, dissolved oxygen, and eH) had stabilized. The wells were then sampled using dedicated disposable bailers for the VOC samples and the peristaltic pump for the remaining samples.

The deep RFI monitoring wells (MW01D-MW09D and MW11) were purged and sampled using a low flow technique with a micro-purge water sampling pump. The deep monitoring wells were purged until indicator parameters had stabilized, which indicated that the groundwater was being drawn from the surrounding glacial deposits. The water level in the wells was not allowed to draw down more than 2 feet from the initial static depth. If drawdown reached 2 feet, the pump automatically shut off until the well could recharge to acceptable limits. A SOP for low flow sampling procedures is included in Appendix L-7.

Summaries of the groundwater indicator parameter measurements obtained during the three monitoring well sampling events are provided in Tables 6, 7, and 7A.

Both unfiltered and field-filtered water samples were collected from the monitoring wells and analyzed for the following parameters: ammonia, chemical oxygen demand (COD), sulfide, sulfate, metals, hardness, alkalinity, chloride, fluoride, cyanide, and nitrate as N. In addition, the unfiltered groundwater samples were analyzed for: VOCs, SVOCs, biochemical oxygen demand (BOD), pH, total dissolved solids (TDS), and total suspended solids (TSS).

Groundwater collected for filtered samples was passed through a dedicated disposable 0.45-micron filter attached to the monitoring well pump discharge line. Quality Assurance / Quality Control (QA/QC) procedures included samples for duplicates, matrix spikes/matrix spike duplicates, equipment blanks, and trip blanks.

2.4.1.2 Potable Water Well Sampling

Potable water well samples were collected from eleven potable wells located near the facility during the first week of September 2001. The potable water well locations sampled were E, F, K, M, N, O, 13, 14, 19, 21, and 22 as shown in Figure 27. A SOP for potable well sampling is included in Appendix L-10.

The potable water wells were purged by allowing the water to run for 10 to 30 minutes. Purging continued until groundwater indicator parameters (i.e., pH, conductivity, and temperature) had stabilized. The wells were then sampled at a faucet located before any water treatment system.

Water samples were analyzed for the following parameters: VOCs, ammonia, chemical oxygen demand (COD), sulfide, sulfate, metals, hardness, alkalinity, chloride, fluoride, cyanide, total dissolved solids (TDS), and total suspended solids (TSS). Quality Assurance / Quality Control (QA/QC) procedures included sample trip blanks for VOCs.

2.4.2 Hydraulic Characterization of Hydrostratigraphic Units

The hydraulic characterization of hydrostratigraphic units consisted of measuring potentiometric head at the RFI monitoring wells and the landfill monitoring wells, measuring surface water at the staff gauge locations, and conducting hydraulic conductivity tests at the RFI monitoring wells.

2.4.2.1 Potentiometric Head and Surface Water Measurements

Potentiometric head refers to the elevation at which groundwater in monitoring wells is in equilibrium with atmospheric pressure. Potentiometric head measurements and surface water measurements for hydrostratigraphic unit hydraulic characterization were obtained at the monitoring wells and staff gauge locations nine times during the RFI: December 2000, January 2001, February 2001, March 2001, April 2001, June 2001, July 2001, August 2001, and October 2001. Groundwater potentiometric data was used to develop potentiometric surface maps and determine horizontal gradients for select hydrostratigraphic units across the study area. The data was also used to determine the direction of vertical hydraulic gradients at the monitoring well nests. A SOP for groundwater level measurement is included in Appendix L-8.

2.4.2.2 In Situ Hydraulic Conductivity Testing

In situ hydraulic conductivity tests were conducted in January, February, and July 2001. Three different methods were used depending on the geology of the screened interval. The bail/pump down method was conducted on well locations MW02S, MW03S, MW04S, MW05S, MW06S, MW07S, MW08S, and MW10 using a whale pump. The pneumatic head method was conducted at well locations MW01D, MW01S, MW03D, MW04D, MW05D, MW06D, and MW07D using a pneumatic head unit and compressed nitrogen gas. The slug test method was performed on MW02D, MW08D, MW09D, MW09S, and MW11 due to the depth of the well and the small thickness of the saturated unit. The slug test method was performed using a PVC slug of known volume. A SOP for aquifer field permeability testing is included in Appendix L-9.

The boring logs and well construction reports provided in Appendix C indicate that the water-bearing units screened by the wells (MW01D, MW01S, MW02D, MW03D, MW03S, MW04D, MW05D, MW06D, MW07D, MW08D, MW08S, MW09D, and MW11) represent confined conditions. The coarser-grained water-bearing units are overlain by finer-grained sediments. The installation of wells in these coarse-grained units revealed that the potentiometric surface is present at a level above the bottom of the overlying confining unit, thereby indicating confined conditions. The data, with one exception, was analyzed using the Cooper, Bredehoeft, and Papadopulos method (Cooper et al. 1967); which is the industry standard for evaluating data from a confined aquifer. Monitoring well MW03S was analyzed using the Bouwer and Rice method (Bouwer and Rice 1976) which, upon evaluation, presented a more appropriate solution.

The boring logs and well construction reports provided in Appendix C indicate that the water-bearing units screened by wells (MW02S, MW04S, MW05S, MW06S, MW07S, MW09S, and MW10) represent unconfined conditions as the water table forms the upper boundary of the aquifer. The data was analyzed using the Bouwer and Rice method, which is an industry standard for evaluating data from an unconfined aquifer.

The data obtained from the hydraulic conductivity tests was downloaded into an electronic database to allow application of regression techniques for computation of hydraulic conductivities. The data was evaluated based on the hydrogeologic conditions present (i.e., confined or unconfined). The data analysis and graphic interpretation was conducted using the Aquifer$^{WIN32®}$ software package developed by Environmental

Simulations, Inc. Data sheets, and Aquifer$^{WIN32®}$ graphs for individual RFI monitoring wells are provided in Appendix D.

2.5 SURFACE WATER AND SEDIMENT INVESTIGATION

The surface water and sediment investigation consisted of sampling the surface water and sediment from the Kaskaskia River and the inlet and outlet channels to the facility. Additionally, sediment samples were collected from the intermittent stream leading from the southwest portion of the site into an offsite pond. Surface water and sediment sampling locations were determined by GPS equipment and are included in Figure 3. A SOP for surface water and sediment sampling is included in Appendix L-2.

2.5.1 Kaskaskia River Sampling

Surface water and sediment samples (SW04/SS04 through SW10/SS10) were collected from five locations along the Kaskaskia River and in the inlet and outlet channels to the facility in November of 2000. Sampling began at the southernmost location and continued north (upstream) to each sampling location. Surface water was sampled before the sediment at each location. Additional sediment samples (SS04a-j and SS06a-e) were collected from the Kaskaskia River near the Baltimore and Ohio Railroad bridge and from the outlet channel from the facility in July of 2001. The Kaskaskia River sampling locations and the inlet were accessed by fishing boat with an electric motor, while the outlet was accessed from the northern bank. The surface water and sediment sampling locations are shown in Figure 3.

2.5.1.1 Kaskaskia River Surface Water

The surface water samples were collected using a laboratory-supplied amber jar. The sample was then transferred into new laboratory-supplied sampling containers. The surface water samples were analyzed for the following parameters: VOCs, SVOCs, ammonia, COD, BOD, sulfide, sulfate, metals, hardness, alkalinity, pH, chloride, fluoride, cyanide, TDS, TSS, and nitrate as N. None of the surface water samples were field-filtered.

2.5.1.2 Kaskaskia River Sediment

Sediment samples were collected from the Kaskaskia River and the inlet and outlet channels using a stainless steel hand auger and metal spoon. The Kaskaskia River sediment samples collected in November 2000, were analyzed for the following parameters: VOCs, SVOCs, PCBs, ammonia, COD, BOD, sulfide, sulfate, metals, hardness, alkalinity, pH, chloride, fluoride, cyanide, and nitrate as N. The Kaskaskia River sediment samples collected in July 2001 were analyzed for polynuclear aromatic hydrocarbons (PAHs) only.

2.5.2 Intermittent Stream Sediment Sampling

Sediment samples (SS01-SS03) were collected from three locations, including one offsite location, along the intermittent stream leading from the southwest portion of the site. The samples were collected during late November and early December 2000. The intermittent stream sediment samples were collected using a stainless steel hand auger and spoon to transfer the sediment into 4-oz. and 8-oz. new laboratory-supplied glass jars. The intermittent stream sediment samples were analyzed for the same parameters as the Kaskaskia River sediment samples discussed in Section 2.5.1.2.

2.6 ECOLOGICAL INVENTORY

The goal of the ecological inventory was to collect information concerning the ecology of the site and the surrounding area. This inventory is intended to assess if either of the following has occurred as a result of site activities.

- An observable reduction in the population of resident flora/fauna.
- Deterioration of local ecosystems (wetlands, sensitive habitats, etc.).

The scope of the inventory was to collect available ecological information at the site and the surrounding area. The primary sources of information for this activity included:

- Previous investigation reports.
- Ground and aerial survey maps and photographs.
- State agency water resource reports.
- Land use documents.
- State agency documents regarding general regional and/or local terrestrial and aquatic ecological characteristics, and critical habitats of endangered and threatened species.
- A wetland delineation for the study area.
- An ecological field survey within an approximate 2-mile radius of the center of the site.

The wetland delineation and ecological field survey was conducted from April 23 to May 1, 2001 to coincide with the beginning of the 2001 growing season, in accordance with the United States Army Corps of Engineers (USACE) requirements (USACE 1987).

2.6.1 Wetland Delineation

A wetland delineation was conducted by Clayton to determine the boundaries of any jurisdictional and non-jurisdictional wetlands, in accordance with the United States Army Corps of Engineers Wetlands Delineation Manual (USACE 1987). The location of the wetland delineation area is shown in Figure 4.

Prior to the wetland delineation, a review of existing information and documents was performed, which included: aerial photographs, United States Department of Agriculture (USDA) Soil Conservation Maps (USDA 1970), United States Fish and Wildlife Service (USFWS) National Wetland Inventory Maps (USFWS 1988), and United States Federal Emergency Management Agency (USFEMA) flood plain maps for Douglas County (USFEMA 1985).

During the wetland delineation, each significant area of distinct land-cover-type and/or vegetation-type was identified for the three variables required by the delineation: the nature of the soil, characterization of the surface hydrology, and the composition of the vegetation. Data on each parameter was collected and recorded on the data delineation form available from the USACE delineation manual (USACE 1987). The data collected on the form was used to assess the extent/boundaries of wetlands and distinguish wetland areas from non-wetland areas.

2.6.2 Ecological Field Survey

An ecological field survey was conducted to further define ecological characteristics within the area shown in Figure 4. The specific activities conducted under this field investigation included:

- Description of local land use patterns.
- Description of local ground and surface water use patterns.
- Description of the local terrestrial and aquatic ecological characteristics and, to the extent possible, local flora and fauna.
- Description of local terrestrial habitat impact.
- Support for the presence of critical habitats for endangered or threatened species as listed by Illinois Department of Natural Resources (Mammen 2001).
- Description of any sensitive habitats in the project vicinity.

3.0 PHYSICAL CHARACTERISTICS OF THE SITE

3.1 SOURCE AREA FEATURES

Two main source areas for potential contamination remain at the site: the WWTP area and the closed fly ash/acid pits and gypsum landfills. The WWTPs consist of 24 unlined lagoons used for storm water, wastewater, and sanitary wastewater treatment. A freshwater pond supplied by the Kaskaskia River and used for potable water for the facility adjoins this area. The WWTP area is located in the northwest section of the site, with an outlet channel to the Kaskaskia River. The landfills are located in the east area of the facility. The landfills have been certified closed (Illinois EPA 1994) and are currently in a post-closure groundwater monitoring program permitted through the Illinois EPA.

According to Mr. Christopher Bland (Health, Safety, and Environmental Manager for Equistar's Tuscola facility), the Freshwater Lake and six sludge treatment lagoons east of the lake (currently only high sludge pond 1 and 2 remain) were constructed in 1952. In 1954, land in the northwest section of the WWTP area was leased, and middle sludge ponds 1 through 6 and low sludge ponds 7 and 8 were constructed. In approximately 1959, high sludge ponds 7 through 10 were completed. In approximately 1961, high sludge ponds 11 through 18 were constructed. By 1979, high ponds 19 and 20 were constructed. Between 1983 and 1986, all of the original sludge ponds located east of the Freshwater Lake, except high ponds 1 and 2 (formerly known as high ponds 2 and 3), had been filled. According to Mr. Jim Bierman (operator / mechanic at the wastewater treatment plant since November 1967), sludge removed from the closed ponds was placed in the gypsum ponds which have since been closed as landfills and are being monitored in accordance with a post-closure permit issued by the Illinois EPA. The location of the sludge ponds is shown in Figure 3. The wastewater treatment system was operated by the

Illinois Water Supply Company (IWSC) until 1977. The wastewater treatment system is now operated by Cinergy.

The WWTPs function as settling and oxidation ponds for the treatment of industrial, sanitary, and storm water discharges from the site. In general, the high ponds serve two roles: diversion capacity and solids storage. Four of the high ponds (by-pass ponds) can be used to divert wastewater that would have entered the treatment plant. The remaining ponds receive solids from the primary clarifier at the treatment plant. The solids settle out in these ponds, and some water is decanted back to the middle ponds. The middle ponds receive the initial discharge of wastewater from the primary clarifier, among other sources. The water is then progressively transferred from the middle ponds into the low ponds prior to eventual discharge into the Kaskaskia River.

Seven landfill areas exist in the northeast and southeast portions of the facility (see Figure 2). Areas 2 through 5 were former gypsum piles and holding ponds. Areas 1, 6, and 7 were former fly ash waste disposal piles. The gypsum was a by-product of phosphoric acid produced on the site from 1957 to 1972. The fly ash waste came from coal burning operations between 1952 and 1993.

Landfill area 5 encompasses approximately 40 acres and was used as a gypsum disposal area until 1972. Areas 3 and 4 cover an area of approximately 20 acres and were the location of the former impoundments for the facility. Any sludge that may have accumulated in these impoundments was generated from the same processes as the wastes in the later landfill uses. Landfill area 2, formerly a gypsum disposal area, encompasses approximately 20 acres, and was capped with sludge from the former impoundments in the early 1970s.

Landfill area 1, formerly a sulfuric acid waste pit and a fly ash disposal area, covers approximately 25 acres and was also capped with sludge from the former impoundments. Fly ash landfill areas 6 and 7 cover an approximate area of 12 acres and 3.5 acres, respectively.

The landfill areas stopped accepting waste in September 1992, and closure was completed in August 1994 (Goedke and Thorsen 1994). All landfills were capped with a 2-foot clay cover (Deigan 1992). Areas 6 and 7 received final cover in July 1993, while final cover of area 1 was completed in November 1993 (Deigan 1994). Area 2 received final cover in May 1994, while final cover for areas 3, 4, and 5 was completed in June 1994. The Illinois EPA (Bakowski 1994) issued a Certification of Closure letter for the landfill areas on December 6, 1994. The post-closure care period began on August 31, 1994.

3.2 REGIONAL SURFACE FEATURES

The study area is located within the Bloomington Ridged Plain subdivision of the Till Plains Section of the Central Lowland Province Physiographic Region of Illinois (Leighton et al. 1948). The surface land surrounding the study area is mostly flat without any significant change in relief (USGS 1983). The Kaskaskia River adjoins the west border of the facility and flows in a southerly direction. The terrain resulted from the Wisconsinan Age glaciation. Ground surface elevation near the facility is approximately 675 feet above msl (USGS 1983). A north-south trending topographic divide exists on the east portion of the site. The terrain gently slopes toward the Kaskaskia River to the west of the divide, and towards the Embarras River to the east of the divide. The surface topography of the study area is shown in Figure 5.

The far western portion of the site adjoining the Kaskaskia River is in the 100-year floodplain according to the Flood Insurance Rate Map (USFEMA 1985). Based on the elevation of the WWTP area, it is unlikely flooding could affect the WWTPs or the developed portion of the site.

3.3 METEOROLOGY

The meteorology of the study area was based on data from NOAA and the Tuscola weather station. According to the *Climatic Atlas of the United States* (NOAA 1983), the average winter temperature near the facility is approximately 30° Fahrenheit (F), and the average summer temperature is approximately 80° F. A minimum temperature equal to or less than 32° F occurs an average of 120 days per year. A maximum temperature of 90° F or above occurs an average of 30 days per year. The average first and last freeze occur on October 20 and April 15, respectively.

According to the *Climatic Wind Data for the United States-Summary* (NCDC 1998), the prevailing wind direction at the nearest wind data weather station located in Springfield, Illinois is from the south and southwest, and the mean annual wind velocity is 11 miles per hour (mph). A Wind Rose Diagram for Springfield, Illinois is provided in Figure 6. The mean annual relative humidity is 70%. According to the publication *Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days 1961-1990-Illinois* (USDC 1991), the mean annual precipitation is 39.62 inches, with the majority of the precipitation occurring in July.

3.4 GEOLOGY

3.4.1 Regional Geology

According to the Illinois State Geological Survey (Illinois SGS) *Geologic Map of Illinois* (Illinois SGS 1967) and *Quaternary Deposits of Illinois* (Illinois SGS 1979), in general, glacial drift overlies Pennsylvanian bedrock throughout most of the region except at the Tuscola Anticline where Middle and Upper Devonian Aged bedrock is found. The stratigraphic sequence beneath the Pennsylvanian Aged strata in the Tuscola area (in increasing geologic age) includes Mississippian, Devonian, Silurian, Ordovician, and Cambrian sedimentary rocks overlying Pre-Cambrian basement rock. Figure 7 shows the bedrock geology of the region surrounding the site.

According to the publication, *Geology and Oil Production in the Tuscola Area, Illinois* (Bristol and Prescott 1968), the Pennsylvanian Aged bedrock is mainly silty or sandy shales with local deposits of sandstones and limestones. The Pennsylvanian shale underlying the Quaternary glacial drift in the study area is predominantly from the McLeansboro Group. The Middle and Upper Devonian Aged bedrock in the Tuscola Anticline, east of the town of Tuscola, consists of shale underlain by limestone. The Upper Devonian shale is known as the New Albany Shale Group. The New Albany Shale is up to 130 feet thick in the Tuscola area. The Tuscola area is also located to the west-southwest of the LaSalle Anticlinal Belt and northeast of the Fairfield Basin. The subject property is located immediately northeast of the Cooks Mills Anticline. The Mattoon Anticline is located approximately 25 miles south of the subject property. The subject property is located approximately 20 miles west of the Murdock Syncline.

The bedrock beneath the subject property and surrounding area is located 40 to 290 feet bgs (Stephenson 1967). The subject property is located along the Pesotum Bedrock Valley, a tributary of the Mahomet Bedrock Valley (see Figure 8). The Mahomet Bedrock Valley is approximately 135 miles long in Illinois and has a topographic relief ranging from 50 to 100 feet in the Tuscola area. The relief of the bedrock valley was the result of pre-glacial, glacial, and interglacial erosion events.

The Quaternary deposits consist of glacial drift, loess, alluvium, and lacustrine sediments deposited during the Pleistocene epoch ice ages and reworking of the glacial sediments following the ice age (Kempton, Morse, and Visocky 1982). The age of these deposits, in decreasing order, includes: Pre-Illinoian, Illinoian, Sangamonian, and Wisconsinan glacial sediments. Figure 9 shows the Quaternary geology of the Tuscola region. The deposits within and overlying the Mahomet and Pesotum Bedrock Valley consist of massive alternating sequences of sand and gravel and clay till deposited during several glacial episodes. In the Tuscola area, the thickness of the glacial drift ranges from 40 to 290 feet. Kempton, Morse, and Visocky (1982) provide a generalized regional cross section from Macon to Vermillion Counties, Illinois. The location reference for the cross section is shown in Figure 10. A reproduction of the cross section is presented in Figure 11.

The older till sequences of the Pre-Illinoian Age include the Upper Member of the Banner Formation. This member consists of massive diamictons with lenses of sand and gravel deposits. The thickness of the Upper Member of the Banner Formation is between 25 to 75 feet thick in the Tuscola area (USGS 1999).

The Pre-Illinoian deposits are overlain by sequences of Illinoian Age glacial deposits consisting of the Lower and Upper Glasford Formation. The Glasford Formation consists of massive diamictons that include, in decreasing age, the Vadailia Till and Radnor Till Members. Lenses of sand and gravel deposits are interspersed between the till members. The Glasford Formation is approximately 50 to 100 feet thick in the Tuscola area.

The Illinoian deposits are overlain by sequences of Wisconsinan Age glacial deposits consisting of the Lower and Upper Members of the Wedron Formation. The Wedron Formation consists of massive diamictons that include, in decreasing age, the Batestown and Piatt Till Members. The Wedron Formation is between 40 and 75 feet thick in the Tuscola area.

3.4.2 Site Geology

The geology of the study area was characterized from the RFI borings, existing landfill monitoring well borings, correlation of geologic cross sections created from the site soil borings, RFI geotechnical results, and interpreted from the *Geologic Map of Illinois* (Illinois SGS 1967), *Quaternary Deposits of Illinois* (Illinois SGS 1979), the *Geology and Oil Production in the Tuscola Area, Illinois* (Bristol and Prescott 1968), the *Hydrogeology of Glacial Deposits of the Mahomet Bedrock Valley in East-Central Illinois* (Stephenson 1967), and the *Hydrogeologic Evaluation of Sand and Gravel Aquifers for Municipal Groundwater Supplies in East-Central Illinois* (Kempton, Morse, and Visocky 1982).

The subject property and the surrounding area are located over a 100- to 200-foot-thick sequence of glacial drift overlying Pennsylvanian Aged bedrock. The stratigraphic sequence beneath the Pennsylvanian Aged strata at the site (in increasing geologic age) includes Mississippian, Devonian, Silurian, Ordovician, and Cambrian sedimentary rocks overlying Pre-Cambrian basement rock.

Geologic cross sections were prepared from selected site borings to illustrate the vertical and horizontal relationship between the various glacial deposits found throughout the site. Figure 12 shows the location of the cross sections. Figure 13 shows cross section A-A,' and Figure 14 shows cross sections B-B' and C-C.' The stratigraphy presented in the cross sections illustrates the major lithologic units at the site: upper glacial till, interglacial layer, middle glacial till, the sand aquifer, and the lower glacial till. The major lithologic units are described below. A summary of the geotechnical testing results for the stratigraphic units is included in Appendix H-6.

The upper glacial till deposit consists of light brown to gray silty clay with some orange mottles and some sand and gravel. The till deposit is most likely associated with the Wedron Formation of the Wisconsinan Stage of glaciation. This till layer is deposited generally flat and is found from grade elevation of approximately 680 feet msl to an average elevation of approximately 635 feet msl. The thickness of this layer ranges from approximately 31 feet (MW07D) to approximately 55 feet (MW09D). The average grain size percentage for this deposit is 36.2% silt, 33.3% clay, 29.1% sand, and 1.2% gravel. The upper glacial till has a 133.1 pounds per cubic foot (pcf) bulk density, a pH range of 7.4 – 9.0, moisture of 12.2%, and a TOC of 1,870 mg/kg.

An interglacial layer consisting of gray-green silts to brown organic silts, peat, and sands underlies the upper glacial till layer. An approximately 5-foot-thick layer of sand is found in a boring (SB08/MW08D) on the east side of the study area. This interglacial layer is associated with the Wisconsinan and Sangamonian Stage of deposition. This layer is generally flat and ranges from approximately 3 feet thick (MW02D) to approximately 25 feet thick (MW01D and MW03D). A sand/silty sand layer was observed at the base of the interglacial layer in the soil borings completed in the center to eastern portions of the facility (MW01D, MW09D, MW11, and landfill monitoring wells G300 and G306). The interglacial layer is generally found between an average elevation of approximately 635 feet msl and an average elevation of approximately 626 feet msl. The average grain size percentage for this deposit is 40.9% sand, 41.5% silt, 14.9% clay, and 2.8% gravel. The interglacial layer has a pH range of 7.3 – 8.7, moisture of 15.1%, and a FOC of 0.60%.

The middle glacial till underlies the interglacial layer. This till is characterized by gray silty clays and clayey silts with lenses of sand and gravel. This glacial layer is associated with the Glasford Formation of the Illinoian Stage of glaciation. Thicknesses range from approximately 16 feet (MW01D) to approximately 31 feet (MW07D). This layer is typically found between an average elevation of approximately 626 feet msl and an average elevation of approximately 600 feet msl. The average grain size percentage for this deposit is 49.3% sand, 30.4% silt, 16.4% clay, and 3.9% gravel. The middle glacial till has a 145.2 pcf bulk density, a pH range of 7.5 – 8.8, moisture of 6.2%, and a TOC of 6,007 mg/kg.

Underlying the middle glacial till is a sand aquifer consisting of alternating layers of fine to coarse, poorly sorted and well-sorted sands with trace amounts of silt. It is also associated with the Glasford Formation of the Illinoian Stage. This sand deposit was found between an average elevation of approximately 600 feet msl and an average elevation of approximately 592 feet msl. The sand aquifer ranges from approximately 1 foot thick (MW08D) to approximately 22 feet thick (MW04D). In general, the sand pinches out to the east as shown in Figure 14, cross sections B-B' and C-C.' The average grain size percentage for this deposit is 81.3% sand, 11.1% gravel, 5.9% silt, and 1.7% clay. The sand aquifer has a pH range of 7.4 – 8.7, moisture of 12.4%, and a FOC of 0.73%.

The lower glacial till layer underlies the sand aquifer. This deposit consists of gray silty clays with low moisture. This till deposit is most likely associated with the Banner Formation of the Pre-Illinoian Stage. The layer was found at the termination of the deep RFI soil borings at the site at an average elevation of approximately 592 feet msl. The thickness of this till unit was not determined by the RFI soil borings. No samples of this layer were collected for geotechnical testing.

3.5 SOIL

The main soil types found in the study area are the Drummer silty clay loam, Flanagan silt loam, Elburn silt loam, and Plano silt loam (USDA 1981). These soils were found in the agricultural fields to the east and north of the site. Soils at the site, including the WWTP area and landfills, could not be mapped because of industrial development.

Drummer silty clay loam is poorly drained and occurs in nearly level areas that occasionally are ponded in winter and early spring. Flanagan silt loam soil is nearly level, somewhat poorly drained, and occurs on till plains and on toe slopes of moraines. Elburn silt loam consists of nearly level to gently sloping, somewhat poorly drained soils that occur on outwash plains. Plano silt loam soils are found on upland ridges and short uneven sided slopes, and are moderately drained and gently sloping. A map of the soils found on and around the study area is included in Figure 15.

3.6 HYDROGEOLOGY

3.6.1 Regional Hydrogeology

The following publications have been used to interpret the regional hydrogeology: *Hydrogeology of Glacial Deposits of the Mahomet Bedrock Valley in East-Central Illinois* (Stephenson 1967) and *Hydrogeologic Evaluation of Sand and Gravel Aquifers for Municipal Groundwater Supplies in East-Central Illinois* (Kempton, Morse, and Visocky 1982). Potable water in the Tuscola area is derived predominantly from the glacial drift. Groundwater in the glacial drift occurs in alluvial deposits, lenses of sand and gravel within the till deposits, and in the massive sand and gravel deposits known as the Mahomet Aquifer within the Mahomet Bedrock Valley.

The town of Tuscola, Illinois and many other nearby municipalities obtain their water supplies from Mahomet, Illinois, which is located approximately 30 miles north of the site. Mahomet, Illinois obtains its water from the Mahomet Aquifer. The towns of Atwood and Arthur, Illinois (located approximately 6 miles west and 10 miles southwest of the site, respectively) obtain their municipal water supply mainly from the Glasford Formation. The Glasford Formation includes the sand and gravel aquifer identified at the site that is approximately 1 to 22 feet thick and occurs between an average elevation of approximately 600 feet msl and an average elevation of approximately 592 ft msl. Most local private wells are screened in the sand aquifer found in the Glasford Formation. Sand and gravel in this formation can reach 50 feet thick in some areas. Figure 16 provides a stratigraphic representation of the glacial and related deposits and their potential as aquifers.

3.6.2 Site Hydrogeology

The hydrogeology of the study area is divided into two hydrostratigraphic units, the shallow glacial drift pathway and the deep glacial drift pathway. The shallow glacial drift pathway is defined as groundwater found within the upper glacial till. Groundwater within the interglacial, middle glacial till, sand aquifer, and the lower glacial till is interpreted as being in the deep glacial drift pathway. Groundwater within the shallow glacial drift pathway is classified as Class II groundwater, while groundwater within the deep glacial drift pathway is considered Class I as defined by 35 Illinois Administrative Code Part 620.

Seven RFI monitoring wells are screened within the shallow glacial drift pathway: MW02S, MW03S, MW04S, MW05S, MW08S, MW09S, and MW10. The remaining 13 RFI monitoring wells (MW01D, MW01S, MW02D, MW03D, MW04D, MW05D, MW06D, MW06S, MW07D, MW07S, MW08D, MW09D, and MW11) are completed in the deep glacial drift pathway. Three of these wells (MW01S, MW06S, and MW07S) are screened in the interglacial with the remaining ten wells (MW01D-MW09D and MW11) screened in the sand aquifer. Geologic information and monitoring well completion details are listed on the boring logs in Appendix C-1 and summarized in Table 4.

Groundwater elevations at the RFI and landfill monitoring wells, and surface water elevations were determined nine times during the RFI (December 2000, January 2001, February 2001, March 2001, April 2001, June 2001, July 2001, August 2001, and October 2001). These elevations were used to develop potentiometric surface maps, determine groundwater flow direction, and calculate horizontal and vertical hydraulic gradients. A summary of the groundwater and surface water elevations is provided in Table 8.

Potentiometric surface maps for the shallow glacial drift pathway and the deep glacial drift pathway are provided in Figures 17 through 21A, B, C, D and Figures 22 through 26A, B, C, and D, respectively. Horizontal and vertical hydraulic gradients are summarized in Tables 9 and 10, respectively.

Hydraulic conductivity tests were performed on RFI monitoring wells during January, February, and July 2001. The average hydraulic conductivity for the shallow glacial drift pathway is 1.03E-03 cm/sec with a geometric mean of 6.93E-05 cm/sec. The average hydraulic conductivity for the deep glacial drift pathway is 7.56E-02 cm/sec with a geometric mean of 8.95E-03 cm/sec. A summary of the data and the calculated hydraulic conductivities is provided in Table 11. Average and geometric mean hydraulic conductivity values for the shallow and deep glacial drift pathways are listed in Table 12.

3.7 KASKASKIA RIVER HYDROLOGY

A morainal ridge that forms a topographic high (trending north-south) is present on the east side of the study area. More than half of the study area (western portion) is located west of the ridge and within the Kaskaskia River drainage basin. The remainder of the study area (eastern portion) is located east of the ridge and within the Embarras River drainage basin. Natural surface drainage to the east of this high flows east to the Embarras River, and surface drainage to the west of this high flows west to the Kaskaskia River. The Kaskaskia River flows in a southerly direction. The majority of the storm water runoff from the facility is collected and routed to the wastewater treatment plant prior to discharging to the Kaskaskia River, which is located approximately 300 feet west of the WWTPs. Since little or none of the facility surface runoff flows into the Embarras River drainage basin, the following surface water hydrology discussion focuses only on the Kaskaskia River drainage basin.

The United States Geological Survey (USGS) maintained a stream gauging station at the inlet to the Freshwater Lake (the Ficklin gauging station) from February 1954 to September 1964 (LaTour et al. 1999). The Kaskaskia River drainage basin, as measured at this gauging station, is 127 square miles.

According to the USGS data, the average discharge rate of the Kaskaskia River for this 10-year period was 77.3 cubic feet per second (cfs). The maximum discharge for this period was recorded on February 10, 1959 at 4,400 cfs. No flow was recorded at times in most years during this period. According to Singh and Stall (1973), the average minimum seven-day low flow for this gauging station ($Q_{7\text{-}10}$) was 0.70 cfs. Typically, the highest rates of discharge occurred during the spring as a result of precipitation, snowmelt, and surface runoff.

There are six unnamed tributaries that flow into the Kaskaskia River within the study area. Two are located upstream of the site (one on each side of the river), and four are located downstream of the site (two on each side of the river). There is an inlet channel from the Kaskaskia River to the Freshwater Lake located on the facility. Treated wastewater from the WWTPs is discharged to the river through an outlet channel, and two facility storm water outfalls also discharge to the Kaskaskia River. It is likely that other small point sources also exist locally. Overland flow from agricultural fields also enters the river locally.

The surface water elevation of the Kaskaskia River was measured at four different staff gauge locations (SG-1, SG-2, SG-3, and SG-4) in December 2000, January 2001, February 2001, March 2001, April 2001, June 2001, July 2001, August 2001, and October 2001. Pooling of water occurred at SG-4 due to debris at this staff gauge location during the months of July, August, and September causing non-representative river elevations during these times. Because of the pooling at SG-4, the average river elevations and average gradient were calculated excluding the July, August, and September 2001 elevation data. The average river elevation at the furthest upstream location (SG-1) during this period was 646.82 feet msl. The average river elevation at the furthest downstream location (SG-) during this period was 645.24 feet msl. The average river elevation drops approximately 1.33 feet between SG-1 and SG-, a distance of approximately 7,750 feet, for a gradient of 0.0002.

The river elevation data was compared with groundwater elevation data collected from nearby monitoring wells (MW06S, MW06D, MW07S, and MW07D) at the same time (see Tables 8). The water elevations in these monitoring wells were 9 to 10 feet higher than the river elevation. This indicates that the Kaskaskia River is a gaining (receiving) stream, that is, groundwater is discharging to the river.

3.8 ECOLOGY INVENTORY

An ecological inventory of the area within 2 miles of the center of the site was completed. The area of the inventory is shown in Figure 4. This figure also shows the area of the wetlands delineation. The purpose of the inventory was to identify the impact, if any, of the site on the environment within the study area. The inventory used ecological endpoints including:

- An observable reduction in the population of resident flora/fauna based on that normally observed in a similar setting.
- A deterioration of local ecosystems based on that normally observed in a similar setting.

Ecological endpoints are environmental characteristics that, if found to be significantly affected, may indicate a need for further evaluation. The following field guides were used to identify the flora and fauna located within the study area: Forest Trees of Illinois (Mohlenbrock 1996), Peterson Field Guide to Mammals (Burt 1980), Eastern Birds, A Guide to Field Identification of North American Species (Coe 1994), The Audubon Society Field Guide to North American Birds-Eastern Region (Bull 1993), A Guide to Wildflowers in Winter (Levine 1995), and A Great Lakes Wetland Flora (Chadde 1998).

The study area is located within a temperate deciduous forest biome that has been modified, primarily, by agricultural activities (Moore 1995). The terrestrial habitat of the study area consisted of agricultural fields, industrial areas, commercial/residential areas, wooded areas, and roadsides. Aquatic habitats consisted of wetland areas, the WWTPs, the Freshwater Lake, the North Plant Lake, the offsite pond, and the Kaskaskia River and its tributaries. The ecology inventory consisted of an evaluation of human ecology (Section 3.8.1), land use and ecology (Section 3.8.2), critical habitats, sensitive environments, endangered or threatened species (Section 3.8.3), and stressed ecosystems

(Section 3.8.4). A summary of the wildlife species identified within a 2-mile radius of the center of the site is provided in Table 13.

3.8.1 Human Ecology

The description of human ecology associated with the study area focuses on population, land and water use, and cultural resources.

3.8.1.1 Demography

The 2000 census data indicates that the population of Douglas County, Illinois is 19,992. The city of Tuscola (located approximately 4 miles east of the site) accounts for 4,448 of this total population. According to the U.S. Census Bureau, a 1996 census estimate indicates that 263 people live within a 2-mile radius of the center of the site.

Douglas County, outside of local municipalities, is not zoned. The area surrounding the site is a mixture of rural, residential, commercial, and industrial; however, it is predominantly agricultural. Most of the existing developed areas within the study area are located along U.S. Highway 36 and northwest of the site along the Kaskaskia River. This includes small businesses and farmhouses. There are also several areas of industrial facilities located within the study area. The industrial facilities are located mainly on U.S. Highway 36. Local industry includes chemical manufacturing, seed processing, and natural gas processing (Rena 2001). Currently, there are no plans on file for construction of residences or small business within the study area (Rena 2001).

3.8.1.2 Water Use

No current water usage information was available for the study area. However, Avery (1995) provides a review of water usage for Douglas County in 1988. The total municipal water supply groundwater withdrawal for Douglas County was approximately 1.06 million gallons per day (mgpd). Self-supplied domestics withdrew approximately 0.34 mgpd of groundwater. An additional 0.36 mgpd was withdrawn for self-supplied livestock, and 0.01 mgpd of groundwater was withdrawn by private industries.

The total water withdrawal for Douglas County is approximately 9.35 mgpd. The total surface water withdrawal for Douglas County in 1988 was about 84% of the total withdrawal noted above, or approximately 7.85 mgpd (Avery 1995). This withdrawal was restricted to self-supplied industry usage and mining withdrawals. Approximately 5.97 mgpd of surface water was withdrawn for industrial usage. Mining withdrawals accounted for an additional approximately 1.61 mgpd of surface water withdrawals with the remaining 0.27 mgpd attributed to other use.

Excluding the facility, there are no potable surface water uses of the Kaskaskia River for municipal or self-supplied domestic purposes within the study area. The closest municipal potable surface water use of the Kaskaskia River is located over 75 miles downstream at Vandalia, Illinois (Battas 2001).

There are no community water supply wells located within 2,500 feet of the site (Christer, 2001). Furthermore, according to Christer (2001), there has not been any regulated recharge areas established in the study area pursuant to section 17.3 of the Illinois Environmental Protection Act. A survey was conducted to determine the presence of potable wells within an approximate 2-mile radius of the site. A previously completed potable well survey (conducted at part of the deep injection disposal well permitting process) was reviewed, and state agencies (Illinois EPA, Illinois DNR, Illinois DPH) were contacted to collect information on the wells in the area. A supplemental field inspection, consisting of a windshield survey to visually observe the location of wells, was conducted during April 2001. As a result of these efforts, 40 potable wells have been identified within a 2-mile radius of the center of the site. The actual number of potable wells may vary because some well installations may not have been reported to appropriate agencies and/or may not be visible from the road. The nearest residential well appears to be located less than 700 feet northwest of the site. Figure 27 shows the locations of the identified water supply wells located within the 2-mile radius. Well completion information concerning the identified wells is presented in Table 14A & 14B. Available well logs are provided in Appendix E. Many of these wells were completed at a depth of 100 feet bgs or less.

On September 5 through September 6, 2001, potable water well sampling was conducted at eleven of the identified wells (E, F, K, M, N, O, 13, 14, 19, 21, and 22). The results of the potable water well sampling are summarized in Appendix H-5A.

The facility's water supply is derived from surface water drawn from the Kaskaskia River. According to Mr. Christopher Bland, Equistar's Health Safety and Environmental Manager, the facility typically withdraws approximately 3.19 mgpd from the river. The closest identified municipal water supply well is located in Atwood, Illinois approximately 6 miles west of the site.

3.8.1.3 Cultural Resources

The National Register of Historical Places (NRHP) was consulted to determine if any significant historical or archaeological sites are located within the study area (NRHP 2001). None are located within the study area; however, three sites (John McCarty

Round Barn, Illinois Central Interlocking Tower, and Streibich Blacksmith Shop) are located within Douglas County.

The round barn, significant as a representative Illinois example embodying the characteristics of a round-type barn, is located in the vicinity of the City of Filson, Illinois. It is more than 9 miles outside of the study area. Therefore, no investigation (or any subsequent remediation) activities will threaten it.

The Illinois Central Interlocking Tower is significant for its historical association with an important rail transportation system from 1889 to 1940. It is located just outside the east end of the city limits of Tuscola, Illinois, and is more than one mile outside the study area. Therefore, no investigation (or any subsequent remediation) activities will threaten it.

The blacksmith shop, significant for reflecting aspects of the history of Newman, Illinois, and the surrounding countryside from the time of settlement of the local prairie during the 19th to mid-20th centuries is located within the City of Newman, Illinois. It is more than 4 miles outside of the study area. Therefore, no investigation (or any subsequent remediation) activities will threaten it.

3.8.2 Land Use and Ecology

Land use interpreted within the study area is illustrated in Figure 28. An evaluation of each land use and its relevance to the ultimate ecological balance of the area is discussed in the following sections.

The term wildlife, as used in this section, refers to non-domesticated populations of plants and animals, both terrestrial and aquatic. The description of wildlife ecology associated with the study area is presented in terms of terrestrial ecology and aquatic ecology. Wetland habitats, which represent ecotones between terrestrial and aquatic habitats, are also addressed.

Land use within the study area (2-mile radius) has been identified as follows:

- 75% agricultural fields
- 15% industrial
- 3% developed (residential and commercial) outside the industrial area
- 4% wetlands/woodlands
- 2% Kaskaskia River and tributaries
- <1% cemetery
- <1% roadsides

3.8.2.1 Agricultural Fields

Approximately three-quarters (75%) of the study area consists of row crop agricultural fields. Corn and soybeans are the major crops harvested from area agricultural lands. These fields are generally well drained and have been altered by farming practices. Contouring of the land and the presence of drainage tiles has produced desired drainage patterns and reduced the potential for ponding of water during wet periods.

During the late spring, summer, and early fall, these fields support vegetative growth utilized by much of the area's wildlife. A summary of the wildlife species identified within a 2-mile radius of the center of the site is presented in Table 13. However; farming practices, which allow for the harvest of most of the vegetative cover in the late fall, leave the majority of these fields barren during the winter months. For this reason, and the fact that farming practices are greatest in the spring and fall (nesting and reproductive periods for most wildlife), these fields are used by wildlife primarily as feeding grounds.

One agricultural field located on the southeast end of the subject property does not appear to have been planted with market crops in the past year. This fallow field is presently a mix of grasslands and corn crop, which supply cover and habitat for a variety of native wildlife of the area.

3.8.2.2 Industrial

Approximately 15% of the study area is used for industrial purposes. The facility comprises approximately 80% of the industrial uses within the study area. The facility has been divided into three areas (chemical processes/offices, ponds, and landfills) for the purposes of this discussion. Most of the other existing industrial areas are located along U.S. Highway 36, southwest and southeast of the site. These include Cabot Corporation and Panhandle Pipelines.

The portions of the Equistar property pertaining to chemical processes/office areas are mainly located in the southern half of the site. Because these areas have been cleared of most vegetative growth and support limited wildlife, they do not contribute significantly to the ecological composition of the study area.

Twenty-four wastewater treatment ponds are located in the northwest end of the site. These WWTPs are part of the facility's wastewater treatment system permitted by the Illinois EPA Bureau of Water (NPDES Permit No. IL0000141). The Equistar facility typically releases approximately 2.04 mgpd from the WWTPs into the Kaskaskia River, according to Mr. Christopher Bland of Equistar. During the field survey, a variety of native wildlife such as fish, amphibians, waterfowl, mollusks, macroinvertebrates, and aquatic mammals was observed in the WWTP area. These ponds provide cover, habitat, and food sources for native and migrating waterfowl and other native wildlife.

Two freshwater ponds are located onsite. One freshwater pond is located south of the WWTPs (Freshwater Lake). This pond is fed by an inlet connected to the Kaskaskia River. This pond provides all potable water to the facility, according to Mr. Christopher Bland of Equistar. The other freshwater pond (North Plant Lake) is located southwest of the landfill (areas 1 through 5). The freshwater pond habitats appeared to be in good condition. The freshwater ponds are used for recreational purposes, such as fishing. A diverse group of aquatic life was observed including fish, amphibians, waterfowl, mollusks, macroinvertebrates, and aquatic mammals. These ponds also provide cover, habitat, and food sources for native and migrating waterfowl and other native wildlife.

Seven landfill areas are found on the site. These landfills are found in the northeast and southeast areas of the facility. The landfills were used for the disposal of process waste from plant operations. In 1993 and 1994, the landfills were closed and capped. A mixture of smooth brome grass and other various grass species now grow on the landfill cap. The landfills supply cover, habitat, and food resources for a variety of native wildlife of the area.

3.8.2.3 Developed Areas

Approximately 3% of the study area (outside of the industrial areas) has been developed. Most of the existing developed areas are located along U.S. Highway 36 and northwest of the site along the Kaskaskia River. This includes small businesses and farmhouses. Because these areas have been cleared of most vegetative growth and support limited wildlife, they do not contribute significantly to the ecological composition of the study area.

3.8.2.4 Wetlands/Woodlands

The wetlands discussion and delineation contained in this section is strictly a scientific application of the 1987 Manual of the USACE to conditions within the study area (USACE 1987). This delineation does not address or make any conclusions as to whether the identified wetland areas are waters of the United States, adjacent to such waters, or otherwise within the jurisdiction of the USACE.

Wetlands/deciduous woodland areas comprise approximately 4% of the study area. The wetlands are associated with the Kaskaskia River and its tributaries, the WWTPs, the facility's freshwater ponds, and drainage swales. Deciduous wooded areas within the study area are found adjacent to the Kaskaskia River and its tributaries. The majority of the wooded areas are located in the 100-year floodplain of the Kaskaskia River (USFEMA 1985) and are occasionally inundated. The major wooded community-type was identified and designated deciduous wetland. The deciduous wetland is dominated by Silver Maple (Acer saccharinum), Black Ash (Fraxinus nigra), and Green Ash (Fraxinus pennsylvanica) trees, which often inhabit the wet soil of stream banks, floodplains, and swampy lowlands. A second wooded community-type was also identified in the upland areas surrounding the wooded deciduous wetland, and was designated as deciduous upland. The vegetative regime of these two distinct ecosystems is as different as their surface hydrology. The deciduous upland wooded areas consist predominantly of Shagbark Hickory (Carya ovata), Sugar Maple (Acer saccharum), Frosted Hawthorn (Crataeus pruinosa), and White Ash (Fraxinus americana) trees, which are commonly found on moist-to-dry uplands.

Abundant wildlife signs were observed in these wetland/wooded areas. Wildlife commonly found within these areas is listed in Table 13. These wetland/wooded areas serve as breeding and nesting areas, as well as a food source for much of the area's wildlife. Hunting occurs within these woods during the fall season. Primary game species include white-tailed deer and squirrels.

Based on a review of documents gathered prior to the wetland delineation, it was determined that there are four different types of wetlands located within the study area. Three of the wetland types fall under the Palustrine System and are called Emergent, Unconsolidated Bottom, and Forested Classes. The fourth wetland type falls under the Lacustrine System and is designated Limnetic Subsystem with a Class of Unconsolidated Bottom. The wetland delineation area is shown in Figure 29. Photographs taken during the wetland delineation are provided in Appendix B.

The Palustrine System is the most dominant wetland system of the study area. The Palustrine System contains all nontidal and tidal wetlands that have a salinity below 0.5% (due to ocean-derived salts). The dominant wetland plant vegetation consists of persistent emergents, emergent mosses and/or lichens, trees, and shrubs. The Palustrine System can also include areas lacking wetland vegetation, but must have the following four characteristics: (1) Salinity of less than 0.5 % that is derived from ocean salts; (2) an area smaller than 20 acres; (3) in the deepest part of water source, have a water depth of less than 2 meters at low water level; and (4) lacking bedrock shoreline features or active wave formation. One other restriction is that the Palustrine System is bound by upland or by any of the other Classified Wetland Systems. Three different Palustrine System Classes are located within the study site. The different Classes are Unconsolidated Bottom Class (PUBFh), Emergent Wetland Class (PEMAf), and Forested Wetland Class (PFO1C).

The Class Unconsolidated Bottom Class is a unique wetland, in that, it includes deepwater habitats with at least 25% cover of particles smaller than stones and vegetative cover less than 30%. They also lack large stable surfaces for plant and animal attachment and are known to be very unstable.

The Emergent Wetland Class is also known as a meadow, fen, marsh, prairie pothole, and slough. The Emergent Wetland Class is characterized by erect, rooted, herbaceous wetland vegetation (hydrophytes), excluding mosses and lichens. The Emergent Class is inhabited by perennial plants that are present for a majority of the growing season, and therefore maintains the same appearance year after year.

The last of the Palustrine System is the Forested Wetland Class. The Forested Wetland Class comprises woody vegetation that is 6 meters tall or taller. Although there are two Forested Wetlands located in the study area, Forested Wetlands are commonly found in the eastern United States and in portions of the West where soil moisture is sufficient (e.g., along rivers and in the mountains).

The Lacustrine System commonly includes wetlands, but also includes deepwater habitats. The following three characteristics are features of the Lacustrine System: (1) located in a dammed river channel or a topographical depression; (2) an area greater than 20 acres; and (3) lacks trees, persistent emergents, shrubs, lichens, or emergents with greater than 30% aerial coverage. Within the study area, two Lacustrine wetlands (the Freshwater Lake and the North Plant Lake) are present; each is part of the Subsystem Limnetic, Unconsolidated Bottom Class.

During the wetland delineation, each significant area of distinct land cover and/or vegetation type was identified for the three variables required by the delineation: the nature of the soil, characterization of the surface hydrology, and composition of vegetation. Data on each parameter was collected and recorded on the 1987 Manual of the USACE, (USACE 1987) data delineation form (Appendix F-1). USDA Soil

Conservation Service maps were utilized to help map the soil within the study area by soil series. Field soil augering was conducted in each wetland type to determine soil characteristics such as mottling, gleying, and soil matrix color. The information from the maps was integrated with the field investigations to further classify soil conditions.

As previously stated, there are four different wetland types located within the study area. The major wetland areas are associated with the Kaskaskia River, the WWTPs, drainage swales, and the facility's two freshwater ponds. The locations of these wetlands are shown in Figure 29.

The wetlands located along the Kaskaskia River are primarily Palustrine-Emergent wetlands; however, two are designated Palustrine-Forested. The determination of Palustrine-Emergent was based on the dominant vegetation of cattails (Typha latifolia), Reed Canary Grass (Phalaris arundinacea), Silver Maple (Acer saccharinum), and Common Reed (Phragmites australis).

The Palustrine-Forested wetland runs along the southern side of the railroad tracks west of the facility. This wetland supports deciduous trees and is dominated by various reed grasses. Evidence supporting this wetland determination is provided by the area's dominant stands of trees – Silver Maple (Acer saccharinum) and Frosted Hawthorn (Crataegus pruinosa) – as well as the floodplain morphology and gleyed soil. Both the Palustrine-Emergent and the Palustrine-Forested wetlands provide excellent habitats for a variety of wildlife throughout the year.

Another wetland area is the WWTPs and the interconnecting drainage swales that flow westerly alongside and between the WWTPs. There is also a larger drainage swale running from the North Plant Lake to the middle ponds (see Figure 29). Evidence supporting this wetland determination is provided by the area's dominant vegetation types: Cattails (Typha latifolia), Rush (Juncus), Common Reed (Phragmites australis), and Bulrush (Scirpus). The presence of standing water, a floodplain morphology, and gleyed soil also support this area's wetland designation.

A third wetland area is represented by the Freshwater Lake and the North Plant Lake. These wetlands are designated Lacustrine-Limnetic-Unconsolidated Bottom wetlands. Evidence supporting this area's designation as a wetland is provided by the lack of dominant vegetation types, presence of standing water, and gleyed soil.

Soil plots were conducted within each of the three identified Palustrine types to verify the classification. Plots were not conducted on the Lacustrine System wetlands (Freshwater Lake and the North Plant Lake) due to the lack of vegetation in each of these wetlands. Each plot consisted of a 30-foot-diameter circle within the wetland type. The plots were measured and located using a GPS unit. The location of each plot is shown in Figure 30. The hydrophytic vegetation was identified, hydrology noted, and the soils described using the Soil Taxonomic Family Classification (USDA 1998). The information collected was reported on the Routine Wetland Determination Data Form (USACE 1987) and is provided in Appendix F-1.

Plot 1 was conducted in a Palustrine System-Forested Class (PFO1C) wetland and is located north of the railroad tracks and west of the Freshwater Lake (see Figure 30). The native species of this plot consist of: Silver Maple (Acer saccharinum), White Ash (Fraxinus americana), Green Ash (Fraxinus pennsylvanica v. subintegerrima), Virginia Creeper (Parthenocissus quinquefolia), Reed Canary Grass (Phalaris Arundinacea), and Bird's Foot Violet (Viola pedata). The hydrology for this plot was determined by the primary and secondary indicators required by the USACE 1987 Manual. The primary indicators present were watermarks and drainage patterns. The secondary indicators present were oxidized root channels in the upper 12 inches of the soil profile, water-stained leaves, local soil survey data, and the Facultative-Neutral test. The soil for this plot is described as Lawson/Silt-loam and is further classified as a fine-silty, mixed, superactive, mesic Aquic Cumulic Hapludolls.

Plot 2 was conducted in a Palustrine System-Unconsolidated Bottom Class (PUBFh) wetland and is located south of the railroad tracks and west of the Freshwater Lake (see Figure 30). The native species of this plot consist of: Sugar Maple (Acer saccharum), White Ash (Fraxinus americana), Wild Onion (Allium Ampeloprasum v. Atroviolaceum), Spring Beauty (Claytonia virginica), Queen Anne's Lace (Daucus Carota), and Woolly Blue Violet (Viola sororia). The hydrology for this plot was determined by the combination of primary and secondary indicators. The primary indicators present were watermarks and drainage patterns. The secondary indicators present were the oxidized root channels in the upper 12 inches of the soil profile, water-stained leaves, local soil survey data, and the Facultative-Neutral test. The soil for this plot is described as Lawson/Silt-loam and is further classified as a fine-silty, mixed, superactive, mesic Aquic Cumulic Hapludolls.

Plot 3 was conducted in a Palustrine System-Emergent Class (PEMAf) wetland and is located west of low WWTP (see Figure 30). The native species of this site consist of: Silver Maple (Acer saccharinum), Blue Beech (Carpinus caroliniana), Frosted Hawthorn (Crataegus pruinosa), Black Ash (Fraxinus nigra), Honey Locust (Gleditsia triacanthos), White Mulberry (Morus alba), Reed Canary Grass (Phalaris arundianacea), and Tumble Mustard (Sisymbrium Altissimum). The hydrology for this plot was determined by the combination of primary and secondary indicators. The primary indicators present were watermarks and drainage patterns. The secondary indicators present were the oxidized root channels in the upper 12 inches of the soil profile, water-stained leaves, local Soil Survey data, and the Facultative-Neutral test. The soil for this plot is described as

Sawmill/Silty Clay and is further classified as a fine-silty, mixed, superactive, mesic Cumulic Endoaquolls.

A Floristic Quality Assessment (FQA) was conducted on each of the three soil plots to evaluate the integrity of the wetlands. This was done in accordance with the *Plants of the Chicago Region* method and software developed by Swink and Wilhelm, 1994. This is an assessment method based upon the character of the regional flora. According to Swink and Wilhelm (1994), it has long been recognized that plants display varying degrees of tolerance to disturbance, as well as varying degrees of fidelity to specific habitat integrity. This concept of species "conservatism" is the basis for the assessment method. The floristic quality of an area is reflected in its inhabitancy of conservative plant species. The basic tool of this method is an evaluation checklist of the plants of the region. Each native species on the checklist has been given a coefficient of conservatism (C value), ranging from 0-10 (Swink and Wilhelm 1994). It is the presence and proportion of conservative native species that underlies the definition of a natural area, not the presence or absence of weeds. It is the extent to which a tract of land supports conservative native plants being indexed. The mean C value $(\overline{C})$ of all plant species present in a plot is multiplied by the square root of the number of native species (N) to obtain the floristic quality index (FQI). The higher the FQI, the better quality of the wetland.

The data recorded on the USACE Routine Wetland Delineation Data Form for each of the soil plots was entered into the software program. The computed results are given in the table below. The program output results are provided in Appendix F-2. A hand calculation showing the computation for Plot 1 is provided in Appendix F-3.

Floristic Quality Assessment Data				
Soil Plot #	**# of Native Species**	**Total Species**	**Native $\overline{C}$**	**Native FQI**
Plot #1	5	6	3.2	7.2

Floristic Quality Assessment Data				
Soil Plot #	# of Native Species	Total Species	Native $\overline{C}$	Native FQI
Plot #2	4	6	3.0	6.0
Plot #3	5	8	4.0	8.9

The results of this limited assessment suggest that the wetlands are stable and have a remnant natural quality. The FQA demonstrates that the facility has not adversely impacted the wetlands. However, it should be noted that it would require a more intensive survey to determine the extent to which conservative species are present within the entire wetland area.

3.8.2.5 Kaskaskia River and Tributaries

The aquatic habitats within the study area also include the Kaskaskia River and its tributaries. The Kaskaskia River borders the site to the west and flows in a southerly direction. Six tributaries flow into the Kaskaskia River within the study area. An inlet channel connects the Freshwater Lake to the Kaskaskia River, and an outlet connects the WWTPs to the Kaskaskia River. The Kaskaskia River and the tributaries comprise approximately 2% of the study area.

The first tributary flows into the east side of the Kaskaskia River approximately 0.5 miles south of U.S. Highway 36. It is fed by runoff from a surrounding agricultural field to the east. A second tributary begins as a drainage swale in the southwest area of the facility. It then flows south and southwest to the offsite pond located on the Bache Church Memorial property, and continues south of U.S. Highway 36 to the Panhandle Pipeline property, where it drains into the Kaskaskia River approximately 1,000 feet south of U.S. Highway 36. A third tributary is located approximately 0.1 miles north of U.S. Highway 36 on the west side of the Kaskaskia River and connects the Kaskaskia with a small pond. The fourth tributary is located approximately 0.4 miles north of U.S. Highway 36 on the west side of the Kaskaskia and is also fed by runoff from surrounding agricultural fields. The fifth tributary is located approximately 1.2 miles north of U.S. Highway 36 on the west side of the Kaskaskia River. The sixth tributary is located approximately 1.8 miles north of U.S. Highway 36 on the east side of the river and is also fed by runoff from the surrounding agricultural fields. Aquatic life observed in all of the tributaries includes: aquatic macroinvertebrates, fish, amphibians, and aquatic macrophytes (plant life).

The inlet channel flows from the Kaskaskia River to the Freshwater Lake. The outlet channel begins in low WWTP 8, flows directly west, and empties into the Kaskaskia River downstream of the inlet channel. Aquatic life was observed in both the inlet and outlet channel and all six of the tributaries, including aquatic macroinvertebrates, fish, amphibians, and aquatic macrophytes (plant life).

The Kaskaskia River's habitat including its tributaries appeared to be in good condition. A diverse group of aquatic life was observed, including fish, amphibians, waterfowl, mollusks, macroinvertebrates, and aquatic mammals. A summary of the wildlife species identified within 2 miles of the site is presented in Table 13.

The Illinois EPA and the Illinois Department of Natural Resources (Illinois DNR) have joint responsibility to monitor and assess the quality of the state's rivers and streams. The Illinois EPA/Illinois DNR have developed a Biological Stream Characterization (BSC) in conjunction with their stream monitoring programs. The BSC is used to assign a class rating to rivers and streams in Illinois.

The Kaskaskia River was upgraded from a "C" rating to a "B" rating, or Highly Valued Aquatic Resource, during the most current BSC in 1997. The BSC rating is based on data documented by the Illinois DNR, including the fish populations, water quality, and aquatic macroinvertebrates (Sauer 2000). The Illinois DNR BSC rating of the Kaskaskia River is found in Appendix G-1. The river is occasionally used for recreational purposes, such as fishing. An Illinois DNR historical listing of fish found inhabiting the Kaskaskia River approximately 3 miles upstream and 0.5 miles downstream from the site is provided in Appendix G-2.

3.8.2.6 Cemetery

Less than 1% of the study area has been designated as a cemetery. This area is located approximately 0.75 miles to the west of the facility on U.S. Highway 36. Because this area has been cleared of almost all vegetative growth and supports little, if any, wildlife, it does not contribute significantly to the ecological composition of the study area.

3.8.2.7 Roadsides

Roadsides comprise less than 1% of the study area. Roadsides exist as small parcels of land that border roads or railroads, of which the majority are not maintained (mowed). Roadsides were too small and numerous to individually map with accuracy.

Although roadsides comprise a small part of the study area, they contribute significantly to the ecological diversity of the area. Because the majority of these areas have no economic use (farming, etc.), they are not managed and; therefore, support valuable vegetative cover throughout the year. Dominant vegetation found in these areas consist of Annual Ragweed (Ambrosia trifida), Queen Anne's Lace (Daucus carota), Ironweed (Vernonia noveboracensis), and Common Dandelion (Taraxacum officinale).

3.8.3 Critical Habitats, Sensitive Environments, and Endangered or Threatened Species

Critical habitats of endangered or threatened species are defined by the Endangered Species Act [50 CFR 424.02(d)]. A request was made to the Illinois DNR for a Natural Heritage Database (NHD) review of potential critical habitats, special features, natural areas, managed areas, and endangered or threatened species within the study area. The database review did not indicate the presence of special features, managed areas, or critical habitat for endangered or threatened species. However, the river is listed on the Illinois Natural Area Inventory (Illinois NAI). The Illinois DNR has identified a stretch of the Kaskaskia River (from U.S. Highway 36 and extending 7.5 miles north or upstream) as a natural area, for having high mussel diversity. This area is referred to as the Kaskaskia River-Chicken Bristle area (Illinois DNR 2001).

A regulatory definition of "sensitive environments" does not exist. However, guidance can be derived from the USEPA Hazard Ranking System (HRS), which is appended to the NCP (40 CFR 300, Appendix A). Table 4-23 (Sensitive Environments Rating Values) of the HRS provides rating values for sensitive environments. Itemized below in order of importance is the rating scheme for sensitive environments as per Table 4-23 of the HRS:

- Critical habitat for federal-designated endangered or threatened species.
- National or state wildlife refuge.
- Federal land designated for protection of natural ecosystems.
- Spawning areas critical for the maintenance of fish/shellfish species, as demonstrated by intense or concentrated spawning by a given species.
- Terrestrial areas utilized for breeding by large or dense aggregations of vertebrate animals.

- National river reach designated as recreational.
- Habitat known to be used by state-designated endangered or threatened species.
- Habitat known to be used by a species under review as to its federal endangered or threatened status.
- State-designated Natural Area.

Using these criteria, there is a single "sensitive environment" in the study area: the Kaskaskia River-Chicken Bristle high mussel diversity stream. The Kaskaskia River-Chicken Bristle high mussel diversity stream meets the "sensitive environment" criteria due to its designation as an Illinois NAI site and the fact that it is a habitat for state-designated endangered and threatened species. No other areas within a 2-mile radius of the center of the site meet the HRS rating criteria for a "sensitive environment."

The Illinois Endangered Species Protection Board (Herkert 1992 and 1994) lists the following endangered or threatened species to inhabit Douglas County as of 1994:

Flora

Scientific Name	Common Name
Panax quinquefolius	Ginseng

Fauna

Scientific Name	Common Name
Epioblasma triquetra	Snuffbox
Gallinua chloropus	Common Moorhen
Lanius ludovicianus	Loggerhead Shrike
Nycticorax nyticorax	Black-Crowned Night Heron
Obovaria subrotunda	Round Hickorynut
Podilymbus podiceps	Pied-billed Grebe
Ptychobranchus fasiolaris	Kidneyshell
Toxolasma lividus	Purple Lilliput
Villosa iris	Rainbow
Villosa lienosa	Rayed Bean
Clonophis kirtlandi	Kirtland's Snake

No critical habitats are designated for any of these species in the study area, with the exception of the Kaskaskia River-Chicken Bristle high mussel diversity stream. Within this high mussel diversity area, one Illinois endangered species (*Villosa lienosa,* Little spectaclecase) and one Illinois threatened species (*Uniomerus tertalasmus*, Pondhorn) were identified (Szafonia 2001). Illinois DNR's database review is provided in Appendix G-3. During the ecological inventory field investigation, no endangered or threatened species or signs of these species were observed.

3.8.4 Stressed Ecosystems

No evidence of stressed flora or fauna was observed during the ecological inventory. Clayton observed miscellaneous debris scattered throughout various portions of the study area. This debris was mostly found in the wetland/wooded areas and was limited to areas smaller than 9 square feet. The debris consisted of white goods, bottles, wire, paper trash, and furniture. No staining or stressed vegetation was present in the vicinity of the debris.

3.8.5 Conclusions of the Ecological Inventory

The ecological inventory was conducted to gather data describing the existing effects, if any, of the site on the environment within the study area. The inventory used ecological endpoints. Ecological endpoints are environmental characteristics which, if found to be significantly affected, may indicate the need for further evaluation. These endpoints include an observable reduction in the population of resident flora/fauna, and/or a deterioration of local ecosystems (wetlands, sensitive habitats, etc). Based on these endpoints, no significant impacts attributable to the facility were observed in the environment of the study area.

4.0 NATURE AND EXTENT OF CONTAMINATION

This section addresses the nature and extent of contamination for the various source media as well as various environmental media. Analytical result summary tables are provided in Appendix H. These tables provide a summary of all constituents detected in the various media sampled during the RFI investigation.

RFI analytical reports from Clayton Group Services Laboratories, Simalabs International, IAS Laboratory, and Great Lakes Analytical are maintained at Clayton's office in Downers Grove, Illinois. These reports are available upon request.

Laboratory analyses were conducted in accordance with USEPA Region V's *RCRA Quality Assurance Project Plan* (QAPP) revised April 1, 1998, with the exception that the solid samples (sludge and sediment samples) submitted for metals analyses were digested in an "as received" state following USEPA Method 3050 protocol to use a representative "wet aliquot." This procedure attempts to take the best representative aliquot of the entire sample. A copy of the laboratory's data quality summary is provided in Appendix I. Certain Practical Quantitation Limits (PQLs) acknowledged in the RFI Work Plan could not be attained due to matrix interference. However, it should be noted that the laboratory instrumentation is able to detect compounds below their respective PQLs. Compounds detected below their respective PQL are flagged with a "J" in the data qualifier column of the laboratory data summary tables provided in Appendix H. The laboratory capable lower detection limit for each of the analytes is provided in Tables 1 and 3.

The concentration levels of the detected constituents within the various media were compared to screening levels provided by 35 Illinois Administrative Code Part 742 (TACO – see Table 16-Screening Levels for Chemicals in Soil, and Table 18-Screening

Levels for Chemicals in Groundwater); USEPA Region 5 Ecological Data Quality Levels (EDQL – see Appendix O); USEPA Region IV Sediment Screening Values (see Table 17); and 35 Illinois Administrative Code Part 302 (General Use Water Quality Standards – see Table 19). Those compounds found at concentration levels above their respective screening levels have been identified as potential contaminants of concern.

4.1 WASTEWATER TREATMENT POND SLUDGE

Two sludge samples were collected from each of the 24 WWTPs. The constituents analyzed were VOCs, SVOCs, PCBs, metals, other major cations and anions, and pH. Laboratory results are summarized in Appendix H-1. Separate tables for detected VOCs (11), detected SVOCs (25), detected PCBs (2), metals, and general chemistry are included. Generally, the high ponds exhibit the highest concentrations of the constituents detected. Concentration levels progressively decreased from the high ponds to the low ponds. This progressive concentration decrease from the high ponds to the low ponds is in keeping with the operation of the WWTPs described in Section 3.1. Table 15 provides a comparison of the number of samples in which a particular compound was detected to the total number of samples collected; and the concentration ranges between the high ponds, middle ponds, and low ponds. The concentration results were compared to the most stringent ingestion and inhalation values provided in Table 16 (Screening Levels for Chemicals in Soil).

Four VOCs of potential concern (benzene, ethylbenzene, toluene, and tetrachloroethene) have been identified in the WWTP sludge samples. Benzene concentrations range from 3 to 12,000 micrograms per kilogram (µg/kg). Benzene concentration levels were found in the high, middle, and low ponds above its screening level. Ethylbenzene, toluene, and tetrachloroethene concentrations range from 6 to 30,000 µg/kg, 6 to 14,000 µg/kg, and

20 to 150 μg/kg, respectively. Concentration levels of these constituents were found above their respective screening levels only in the high ponds.

Six SVOCs of potential concern, mainly polynuclear aromatic hydrocarbons (PAHs), were detected in the WWTP sludge samples. The compounds detected include benzo(a)anthracene (10 to 23,000 μg/kg), benzo(a)pyrene (28 to 14,000 μg/kg), benzo(b)fluoranthene (22 to 6,400 μg/kg), dibenzo(a,h)anthracene (20 to 1,400 μg/kg), indeno(1,2,3-cd)pyrene (10 to 3,800 μg/kg), and naphthalene (20 to 610,000 μg/kg). SVOC concentrations also progressively decrease from the high ponds to the low ponds. Concentration levels of benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene were found in the high, middle, and low ponds above their respective screening levels. Dibenzo(a,h)anthracene and indeno(1,2,3-cd)pyrene were found above their respective screening levels only in the high and middle ponds. Naphthalene was found above its screening level only in the high ponds.

PCBs were detected in only two samples collected from the high ponds. Sample SL15HA contained arochlor 1254 at 640 μg/kg and arochlor 1260 at 430 μg/kg. Sample SL18HB only contained arochlor 1254 at 460 μg/kg. These concentration levels are essentially at or below the screening level for PCBs of 1,000 μg/kg (see Table 16). Given this and the fact that PCBs were detected in only two of the 48 samples collected from the WWTPs, PCBs do not represent a potential contaminant of concern.

Three metals of potential concern have been identified. Arsenic, beryllium, and total chromium were found at concentrations above their respective screening levels throughout all of the WWTPs. Arsenic was detected at 900 to 190,000 μg/kg, beryllium at 270 to 5,500 μg/kg, and total chromium at 19,000 to 3,200,000 μg/kg.

No general chemistry compounds have been identified as potential contaminants of concern. As with the other compounds detected in the sludge samples, concentration levels of the general chemistry compounds are generally highest in the high ponds, decreasing in the middle ponds, and lowest in the low ponds.

In summary, four VOCs, six SVOCs, and three metals of potential concern have been identified in the WWTP sludge.

4.2 SURFACE WATER AND SEDIMENT

Surface water and sediment samples were collected from the Kaskaskia River to characterize the surface water and associated sediment in the study area and to determine potential impacts from the facility. Sediment samples were also collected from the intermittent stream that flows from the southwest portion of the facility to the offsite pond. Initial sampling was conducted during November 2000. Additional sediment samples were collected in July 2001 to further assess the sediment quality. Sample locations are shown in Figures 3A and 3B.

4.2.1 Kaskaskia River

Surface water and sediment samples were collected from five locations along the Kaskaskia River. In addition, a surface water and sediment sample was collected from the inlet channel and the outlet channel from the river to the facility (see Figure 3). Sample locations SW04/SS04 and SW05/SS05 were downstream of the inlet/outlet channels. Sample locations SW08/SS08, SW09/SS09, and SW10/SS10 were upstream of the inlet/outlet channels. Sample location SW06/SS06 was from the outlet channel, and sample location SW07/SS07 was from the inlet channel. Ten additional sediment samples were collected from the river near SS04(A-J) and five additional sediment samples were collected from the outlet channel near SS06(A-E) in July 2001 (see Figure 3A).

The discharge of the river (during the November 29, 2000 surface water sampling event) was composed of approximately 60% groundwater contributions and 40% overland flow. This was determined by evaluation of the precipitation records and the river discharge records for the area during this time period. The most recent precipitation event (prior to the river sampling) occurred on November 25, 2000 with 0.65 inches of rainfall (Appendix J). The precipitation data is recorded at the Illinois State Water Survey (Illinois SWS) station in Champaign, Illinois, located approximately 30 miles northeast of the site. Graph 1 shows the monthly precipitation totals from this station for the period of January 1996 through April 2001. As noted in Section 3.7, the USGS river gauging station, formerly located at the site (the Ficklin gauging station), is no longer used. The next downstream gauging station (that has current river discharge data) is in Chesterville, Illinois (located approximately 7 miles downstream from the Ficklin gauging station). The Kaskaskia River daily mean discharge at the USGS Chesterville gauging station on November 29, 2000 was 153.1 cfs (Appendix K).

A conversion factor was used to convert the daily mean discharge values recorded at the Chesterville gauging station to be representative of the daily mean discharge values at the former Ficklin gauging station. The conversion factor was arrived at by dividing the drainage area above the former Ficklin gauging station (127 square miles) by the drainage area above the Chesterville gauging station (358 square miles). The conversion factor used was 127 divided by 358 equals 0.355. The converted daily mean discharge values (representing the river discharge at the former Ficklin gauging station) were used to create mean discharge rates for the period January 1996 through March 2001 presented in Graph 2. This information, along with the precipitation information, was used to create the hydrograph shown in Graph 3.

4.2.1.1 Kaskaskia River Surface Water

Five surface water samples (SW04, SW05, SW08, SW09, and SW10) were collected from the Kaskaskia River (see Figure 3), and a surface water sample was collected from the outlet channel (SW06) and the inlet channel (SW07) of the facility. Surface water samples collected downstream of the facility are similar in quality to the surface water samples collected upstream of the facility. Three VOCs (2-butanone, acetone, chloroform) and eight SVOCs [2-methylnaphthalene, acenaphthalene, anthracene, bis(2-ethylhexyl) phthalate, fluorene, naphthalene, phenanthrene, and pyrene] were detected in one or more of the surface water samples. Summary tables of the analytical results are included in Appendix H-2.

The surface water analytical results were compared to the surface water screening levels provided in Table 19 and the USEPA Region 5 surface water EDQLs provided in Appendix O. Those compounds and their respective concentration levels that are above the screening levels provided in Table 19 or Appendix O are bolded and underlined in the surface water results tables provided in Appendix H-2. No VOCs, SVOCs, metals, or other general chemistry constituents were found in excess of the human health surface water screening levels provided in Table 19. However, two SVOCs were found to exceed the USEPA Region 5 surface water EDQLs (Appendix O) in the water sample collected from the river at the railroad bridge downstream of the facility (SW04). Anthracene was detected at a concentration of 0.2 ug/L, which exceeds the EDQL for anthracene of 0.029 ug/L and pyrene was detected at a concentration of 0.4 ug/L, which exceeds the EDQL for pyrene of 0.3 ug/L. These contaminants are commonly associated with the preservatives in railroad ties; and therefore, may be attributable to leaching of the contaminants from the ties into the river. Furthermore; these contaminants were not detected in any of the surface water samples collected upstream of this location, including: sample SW05, which is located between the railroad bridge and the facility and sample SW06, which was collected from the wastewater treatment ponds outlet channel. Therefore, anthracene and pyrene are not considered as potential surface water contaminants of concern attributable to the facility.

Copper was also detected in the surface water samples at concentration levels above the USEPA Region 5 EDQL of 5 ug/L. The upstream sample locations (SW09 and SW10) had the highest copper concentration levels at 5.1 ug/L and 6.8 ug/L, respectively. Given this, copper is not regarded as a potential surface water contaminant of concern attributable to the facility.

4.2.1.2 Kaskaskia River Sediment

Five sediment samples (SS04, SS05, SS08, SS09, and SS10) were collected from the Kaskaskia River (see Figure 3), one sediment sample was collected from the outlet channel (SS06), and one sediment sample was collected from the inlet channel (SS07) of the facility, all in November 2000. Additional sediment samples (SS04A-J and SS06A-E) were collected and analyzed for PAHs from the Kaskaskia River near the Baltimore and Ohio Railroad bridge and from the outlet channel from the facility in July of 2001. Seven (7) VOCs and seventeen (17) SVOCs were detected in one or more of the river sediment samples. No PCBs were detected in any of these samples. The detected VOCs include:

Acetone	Ethylbenzene	Toluene
Benzene	Methylene Chloride	Xylenes, total
Carbon disulfide		

The detected SVOCs include:

2-Methylnaphthalene	Benzo(b)fluoranthene	Fluorene
Acenaphthene	Benzo(g,h,i)perylene	Indeno(1,2,3-cd)pyrene
Acenaphthylene	Benzo(k)fluoranthene	Naphthalene

(Continued from Previous)

Anthracene	Chrysene	Phenanthrene
Benzo(a)anthracene	Dibenzo(a,h)anthracene	Pyrene
Benzo(a)pyrene	Fluoranthene	

Summary tables of the analytical results are included in Appendix H-3 for those samples collected in November 2000, and Appendix H-3A for those samples collected in July 2001.

The sediment sample analytical results were compared to the most stringent screening levels provided in Table 16 for the ingestion or inhalation exposure routes, the USEPA Region IV sediment screening levels provided in Table 17, and the USEPA Region 5 sediment EDQLs provided in Appendix O. Those compounds and their respective concentration levels that are above the screening levels provided in Table 16, Table 17, or Appendix O are bolded and underlined in the sediment results tables provided in Appendix H-3 and Appendix H-3A. Following is a discussion of the constituents detected in the sediment samples:

VOCs

Of the seven (7) VOCs detected in the sediment samples, none were detected at concentration levels above the sediment screening levels provided in Tables 16 and 17. However, acetone and ethylbenzene were detected at concentrations above the sediment screening values provided in USEPA Region 5's EDQLs (Appendix O). Acetone was detected in sample SS07 (the inlet channel) at a concentration of 560 ug/kg, which is slightly above the EDQL of 453 ug/kg; and ethylbenzene was detected in samples SS04 and SS08 at 6 J ug/kg and 5 J ug/kg, which is above the EDQL of 0.1 ug/kg. The "J" qualifier means that this is an estimated value and that the compound was detected below the practical quantitative limit.

SVOCs

The seventeen SVOCs detected in the Kaskaskia River sediment samples during the November 2000 sampling event are all PAHs. These same PAHs were detected in the additional sediment sampling that was conducted in July 2001. Of those compounds detected during the November 2000 sampling event, three (3) compounds were detected above the sediment screening levels provided in Table 17 and thirteen (13) compounds were detected above the sediment screening levels provided in USEPA Region 5's EDQLs (Appendix O). In the river sediment samples collected during the July 2001 sampling event (SS04A – SS04J), seven (7) compounds were detected above the sediment screening levels provided in Table 17 and fifteen (15) compounds were detected above the sediment screening levels provided in USEPA Region 5's EDQLs (Appendix O). In the sediment samples collected from the outlet channel during the July 2001 sampling event, twelve (12) compounds were detected above the sediment screening levels provided in Table 17 and sixteen (16) compounds were detected above the sediment screening levels provided in USEPA Region 5's EDQLs (Appendix O).

Table 22 provides a summary of the PAHs detected in the river and the outlet channel sediment samples. The USEPA Region IV sediment screening levels (from Table 17) and the USEPA Region 5 sediment EDQLs (from Appendix O) are also shown in Table 22.

METALS

Six (6) metals (arsenic, cadmium, chromium, copper, nickel, and zinc) were detected in the river sediment samples at concentration levels above either the sediment screening levels provided in Table 17 or the sediment screening levels provided in USEPA Region 5's EDQLs (Appendix O). Table 23 provides a summary of the metals detected in the river sediment samples. The USEPA Region IV sediment screening levels (from Table 17) and the USEPA Region 5 sediment EDQLs (from Appendix O) are also shown in Table 23.

Cyanide was also detected in the river sediment samples at concentration levels above the USEPA Region 5 EDQL of 0.0001 mg/kg. The upstream sample locations (SS09 and SS10) had the highest cyanide concentration levels at 0.85 mg/kg and 1.3 mg/kg, respectively. Given this and the lack of any known use or generation of cyanide at the facility, cyanide is not regarded as a potential contaminant of concern attributable to the facility.

In summary, two (2) VOCs (acetone and ethylbenzene), the PAHs, and six (6) metals (arsenic, cadmium, chromium, copper, nickel, and zinc) are potential contaminants of concern in the Kaskaskia River sediments.

4.2.2 Intermittent Stream Sediment

Three sediment samples (SS01, SS02, and SS03) were collected from the intermittent stream that drains from the southwest portion of the facility to an offsite pond located west of the facility and just north of U.S. Highway 36 (see Figure 3). One (1) VOC (methylene chloride) and seventeen (17) SVOCs were detected in one or more of the intermittent stream sediment samples. No PCBs were detected in any of these samples. The detected SVOCs include:

2-Methylnaphthalene
Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
Chrysene
Dibenzo(a,h)anthracene
Fluoranthene
Fluorene
Indeno(1,2,3-cd)pyrene
Naphthalene
Phenanthrene
Pyrene

Summary tables of the analytical results are included in Appendix H-4. The sediment sample analytical results were compared to the most stringent screening levels provided in Table 16 for the ingestion or inhalation exposure routes, the USEPA Region IV sediment screening levels provided in Table 17, and the USEPA Region 5 sediment EDQLs provided in Appendix O. Those compounds and their respective concentration levels that are above the screening levels provided in Table 16, Table 17, or Appendix O are bolded and underlined.

Methylene chloride was detected in two of three samples (SS02 at 7 J and SS03 at 5 J μg/kg). However, these concentrations are below the above screening levels.

PAHs were detected in the sediment in the southwest portion of the facility (SS01) and immediately west of Ficklin Road (SS02). No PAHs or other SVOCs were detected in the sample collected from the offsite pond (SS03), which receives the intermittent stream flow.

Two (2) of the PAH compounds detected in samples SS01 and SS02 were detected at concentration levels above the sediment screening levels provided in Table 17, and thirteen (13) of these compounds were detected at concentration levels above the sediment screening levels provided in USEPA Regions 5's EDQLs (Appendix O). Table 24 provides a summary of the PAHs detected in the intermittent stream sediment samples. The USEPA Region IV sediment screening levels (from Table 17) and the USEPA Region 5 sediment EDQLs (from Appendix O) are also shown in Table 24.

Four (4) metals (arsenic, chromium, copper, and nickel) were detected in intermittent stream sediment samples SS01and SS02 at concentration levels above either the sediment screening levels provided in Table 17 or the sediment screening levels provided in USEPA Region 5's EDQLs (Appendix O). No metals were detected in sample SS03 above these screening levels. Table 23 provides a summary of the metals detected in the intermittent stream sediment samples SS01 and SS02. The USEPA Region IV sediment screening levels (from Table 17) and the USEPA Region 5 sediment EDQLs (from Appendix O) are also shown in Table 23.

Cyanide was also detected in intermittent stream sediment samples SS01 and SS02 at concentration levels above the USEPA Region 5 EDQL of 0.0001 mg/kg. It was not detected in the offsite pond sample (SS03).

In summary, the PAHs, four (4) metals (arsenic, chromium, copper, and nickel), and cyanide are potential contaminants of concern in the intermittent stream sediments.

4.3 GROUNDWATER

RFI monitoring wells were sampled during three separate sampling events (December 2000, March 2001, and August 2001). In addition, water samples were collected from eleven (11) potable water supply wells located around the facility in September 2001. The locations of the potable water supply wells sampled are shown in Figure 27 and are identified as 13, 14, 19, 21, 22, E, F, K, M, N, and O.

Summary tables of the RFI monitoring well analytical results are included in Appendix H-5. Summary tables of the potable water supply well analytical results are provided in Appendix H-5A. The analytical results were compared to the Class I/Class II groundwater screening levels provided in Table 18. Those compounds and their respective concentration levels that are above the screening levels provided in Table 18, are bolded and underlined. A discussion of the potable water supply well analytical results followed by a discussion of the facility monitoring well analytical results follows.

4.3.1 Potable Water Supply Wells

No VOCs were detected in any of the potable water supply well samples. The metal and general chemistry compounds detected are all within either expected ranges for natural occurrence in groundwater or acceptable limits established by the Illinois Pollution Control Board (Illinois PCB) for groundwater that serves as a drinking water supply, with the following exceptions.

Iron was detected in samples collected from potable water supply well locations 14 (5,100 ug/L) and K (5,400 ug/L), at concentration levels above the limit established by the Illinois PCB of 5,000 ug/L. Iron is a secondary contact concern typically regulated for cosmetic or aesthetic reasons. High levels may cause rusty colored water or rust staining of laundry or bathroom fixtures. Based on the samples from the other potable supply wells and from the facility monitoring wells, the elevated iron levels are not caused by operations at the facility.

Lead was detected in samples collected from potable water supply well locations 21 (8.7 ug/L) and 22 (13 ug/L), at concentration levels above the limit established by the Illinois PCB of 7.5 ug/L. Lead is commonly associated with the plumbing in older homes. Some old homes have lead pipes or connections. It is also found in the solder used with copper plumbing of many homes. The lead does not appear to be associated with the groundwater as the lead levels detected in all the other potable water supply well samples and the deep facility monitoring wells are below the limit established by the Illinois PCB.

4.3.2 Facility Monitoring Wells

Groundwater within the shallow glacial drift pathway is classified as Class II groundwater, while groundwater within the deep glacial drift pathway is considered Class I groundwater as defined by 35 Illinois Administration Code Part 620 (see discussion in Section 3.6.2). Figure 31 includes selected groundwater analytical results for the December 2000, March 2001, and August 2001 groundwater sampling events.

The analytical results from the landfill groundwater monitoring program have also been reviewed. The closed landfills have had a groundwater monitoring program (permitted through the Illinois EPA) since 1994. Those monitoring wells associated with the landfill groundwater monitoring program are the "G" series wells shown in Figure 2. The landfill groundwater monitoring program consists of 17 compliance monitoring wells (G101 through G118, excluding G104, which has been abandoned) and 14 assessment monitoring wells (G119 through G125, G200, G201, G206, G209, G300, G306, and G309). Summary tables presenting available groundwater analytical results for the landfill monitoring wells are provided in Appendix M. VOC results and inorganic results from the landfill compliance monitoring wells are provided in Appendix M-1 and M-2, respectively. VOC results and inorganic results for the landfill assessment monitoring wells are provided in Appendix M-3 and M-4, respectively.

Following is a discussion of the constituents detected in the groundwater below the facility.

<u>VOCs</u>

The VOCs detected in groundwater collected from the RFI monitoring wells are benzene, chloroform, cis-1,2-dichloroethene, and vinyl chloride. The VOCs of potential concern were detected in only one RFI monitoring well (MW03S). No VOCs have been detected above screening levels in any of the landfill compliance or assessment monitoring wells.

Chloroform was detected in nine (9) of the ten (10) deep RFI monitoring wells (MW01D, MW03D, MW04D, MW05D, MW06D, MW07D, MW08D, MW09D, and MW11) and three of the shallow RFI monitoring wells (MW01S, MW03S, and MW06S) at concentrations above the Class I and Class II groundwater screening levels of 0.02 micrograms per liter (μg/L) and 0.1 μg/L, respectively. Bromodichloromethane, which is associated with chloroform, was also detected in three RFI monitoring wells (MW01D, MW06S, and MW07D) during the December 2000 groundwater sampling event.

The chloroform appears to have been introduced during the installation of the monitoring wells. A review of the data reveals that the only samples where chloroform is detected are samples collected from monitoring wells where water had to be added during the completion of the soil boring for the monitoring well. Furthermore, the number of monitoring wells where chloroform is detected decreased during each successive sampling event. During the December 2000 event, chloroform was detected in eleven (11) samples. It was only detected in five (5) samples during the March 2001 sampling event. During the August 2001 sampling event, it was only detected in three (3) samples (one of which being from MW11, which was installed in July 2001).

Water was added to aid the drilling at a number of the deeper monitoring well locations. The water used for this was obtained from the facility's fire fighting system. A sample of this water was collected for laboratory analysis on October 8, 2001. A copy of the laboratory analytical results is provided in Appendix P. A review of these results shows that chloroform is present in this water source at a concentration of 48 ug/L. Bromodichloromethane and dibromochloromethane were also found in this sample at concentrations of 7.3 and 1.1 ug/L, respectively. Given the above, chloroform is not considered a potential contaminant of concern.

Benzene, cis-1,2-dichloroethene, and vinyl chloride were detected only in RFI monitoring well MW03S (located between the Freshwater Lake and the wastewater treatment plant, see Figure 2). These potential VOCs of concern were found during all three (3) rounds of groundwater sampling at concentrations above the groundwater screening levels in Table 18. The presence of these contaminants at this location may be attributable to high ponds 1 and 2 (by-pass ponds), located less than 200 feet east of MW03S. None of these VOCs were detected in RFI monitoring well MW10 (located approximately 200 feet south of MW03S and 200 feet north of the facility's southern border). This indicates the VOC impacts are of limited extent and are contained on site.

SVOCs

SVOCs were detected in samples collected from monitoring well MW04S (located between the WWTPs and the Freshwater Lake, see Figure 2) during the March 2001 and the August 2001 sampling events. However, groundwater at MW04S is considered Class II groundwater and the concentration levels in the samples are below the Class II groundwater screening levels in Table 18. Therefore, the SVOCs detected at this location are not considered potential contaminants of concern.

Three (3) SVOCs [benzo(a)anthracene, benzo(b)fluoranthene, and benzo(k)fluoranthene] were detected at concentration levels above the Class I groundwater screening level for these compounds in the sample collected from monitoring well MW01S during the August 2001 sampling event. No SVOCs were detected in samples collected from this monitoring well during December 2000 or March 2001. Furthermore, no SVOCs have been detected in any of the monitoring wells screen in the deep galacial drift pathway during any of the sampling events. These SVOCs are PAHs, a component of products including asphalt, tar, and road oil. On the day this sample was collected during the August sampling event (August 7, 2001), the air temperature was in the upper 90 degree range and the field sampling team noted that the county road located near this monitoring well had recently been oiled and there was an oily / road tar odor in the air. Mr. Ed Schwesher (Garrett Township Highway Department) confirmed that a layer of oil and rock was placed on the road located near MW01S in July. Given this, the PAHs found in the August sample from MW01S is attributed to cross-contamination of the sample from vapors coming from the road oil and not associated with the contaminants being present in the groundwater. Therefore, these are not considered as potential contaminants of concern.

Bis(2-ethylhexyl)phthalate was detected at low concentration levels in numerous samples including background monitoring wells MW08S, MW08D, and MW09D. Phthalates are plasticizers found in most plastic products that can be introduced into the samples during sampling handling. Furthermore, bis(2-ethylhexyl)phthalate is a common laboratory artifact that can be introduced into the samples during the sample extraction process. It was, in fact, detected in the laboratory blanks associated with the August 2001 sampling event. Therefore, bis(2-ethylhexyl)phthalate is not considered a potential contaminant of concern.

METALS

Metals of potential concern detected in the RFI monitoring wells are boron, iron, lead, and manganese. Boron was not found in the groundwater of the shallow glacial drift pathway above 700 µg/L. Boron was found in all the groundwater samples collected from the deep glacial drift pathway at concentrations of 1,000 ug/L or above. Overall, boron was not detected above its Class I or Class II groundwater screening level of

2,000 μg/L in groundwater samples collected from any of the RFI monitoring wells. However, since 1994, it has been observed at concentrations exceeding the 2,000 μg/L screening level in groundwater samples collected from several of the onsite landfill monitoring wells (G112, G113/R113, and G118). Therefore, boron has been included as a potential contaminant of concern.

The boron levels in groundwater (beyond that immediately below the landfills) appear to be a regional issue given that all of the deep RFI monitoring wells (including MW08D, which is upgradient of the facility) have concentration levels at or above 1,000 μg/L. Furthermore, many of the potable water supply wells sampled [including the two located east (upgradient) of the facility] have boron concentrations above 900 ug/L.

Boron is a constituent sometimes found in fly ash that is contained in the closed landfills. Therefore, the boron found in some of the landfill monitoring wells may be partially attributable to the landfills.

Iron was detected at concentrations above the groundwater screening level of 5,000 μg/L, during one or more of the groundwater sampling events in seven of the ten shallow RFI wells (MW01S, MW02S, MW03S, MW04S, MW06S, MW07S, and MW09S) and six of the ten deep RFI monitoring wells (MW03D, MW04D, MW05D, MW06D, MW07D, and MW08D). Iron has also been detected at concentration levels above the screening level in several of the landfill monitoring wells (G103, G108, and G112). Iron was also detected in two (2) of the potable water well samples at concentrations above the screening level. This pattern would appear to indicate that iron is a regional issue not related to the facility. Iron is a secondary contact concern typically regulated for cosmetic or aesthetic reasons.

Lead was detected in RFI monitoring well MW04D at a concentration of 9.2 ug/L (March 2001 sampling event only), which is above the Class I groundwater screening level of 7.5 μg/L (Table 18). Lead was also detected in RFI monitoring well MW06S at a concentration of 100 ug/L (August 2001 sampling event only). It was not detected during the previous sampling events (December 2000 and March 2001) above 3.2 ug/L.

Furthermore, it is noted that a number of other metals were detected at concentration levels one to two orders of magnitude higher in the August 2001 sampling event versus the December 2000 and March 2001 sampling events for MW06S. It is also noted that no lead was detected in the field filtered sample from the August 2001 sample of MW06S. Therefore, the lead detected in the August 2001 sample from MW06S is attributed to sediment in the sample and not the groundwater. No lead was detected above the Class II groundwater screening level of 100 μg/L (Table 18) in any of the RFI monitoring wells screening Class II groundwater. However, lead has been detected above the Class II groundwater screening level in one of the landfill monitoring wells (G112) screening Class II groundwater.

Manganese was detected above the Class I groundwater screening level of 150 μg/L (Table 18) in nine (9) of the thirteen (13) RFI monitoring wells screening Class I groundwater (MW01S, MW03D, MW04D, MW05D, MW06S, MW07D, MW07S, MW08D, and MW11) during one or more of the groundwater sampling events. Manganese was not detected above the Class II groundwater screening level of 10,000 μg/L (Table 18) in any of the RFI or landfill monitoring wells screening.

GENERAL CHEMISTRY

Other potential contaminants of concern detected in the RFI monitoring wells are chloride, sulfate, and TDS. Chloride was detected above its screening level (200 mg/L) in groundwater samples collected only from MW03S during all three (3) sampling events. Chloride has also been detected above the screening level in landfill monitoring wells G110 and G113/R113.

Concentrations of sulfate were detected above its screening level (400 mg/L) in groundwater samples collected from both MW01S and MW04S (March 2001 and August 2001 sampling only), MW03S (December 2000 and August 2001 sampling only), and MW05S (December 2000, March 2001, and August 2001 sampling). Sulfate has also been detected above the screening level in several of the landfill monitoring wells (G105, G106, G108, G109, G110, G112, G113/R113, G114, and G115).

While no groundwater screening level is provided for TDS, concentration levels of TDS were detected above the Groundwater Quality Standard (1,200 mg/L) provided in 35 Illinois Administration Code Part 620 in groundwater samples collected from MW03S (December 2000, March and August 2001 sampling); MW04S (August 2001 sampling only); MW05S (December 2000, March and August 2001 sampling); and MW09D (March 2001 sampling only). TDS has also been detected above the standard in several landfill monitoring wells (G105, G106, G108, G109, G110, G112, and G113/R113).

Observation of the groundwater geochemistry across the site indicates that the monitoring wells completed in the shallow glacial drift pathway typically exhibit aerobic conditions (dissolved oxygen concentration greater than 0.5 parts per million [ppm]). The deep glacial drift pathway exhibits anaerobic conditions (dissolved oxygen less than approximately 0.5 ppm). There appear to be a few isolated areas of shallow groundwater exhibiting anaerobic conditions, but this is believed to have been caused by elevated organic carbon in the groundwater accompanied by sufficient microbiological activity at these locations to create anaerobic conditions. Two general observations can be made with regard to sulfate and the availability of dissolved oxygen in groundwater: (1) at locations across the site where shallow groundwater exhibits aerobic conditions, sulfate concentrations are higher; and (2) at locations across the site where groundwater exhibits anaerobic conditions, sulfate concentrations are lower.

SUMMARY

Three (3) VOCs (benzene, cis-1,2-dichloroethene, and vinyl chloride), four metals (boron, iron, lead, and manganese), and three additional inorganic parameters (chloride, sulfate, and total dissolved solids) are potential contaminants of concern in groundwater.

5.0 CONTAMINANT MIGRATION PATHWAYS

This section discusses the potential contaminant migration pathways and the potential for the contaminants to migrate along these pathways. The migration of these potential contaminants is controlled by the physical, geological, and hydrogeological conditions of the area; the characteristics of the source areas; and the physical and chemical characteristics of the contaminants. This section will provide a general discussion of the most probable migration pathways, the observed and predicted behavior of contaminants, and the contaminants' potential for mobility in various media.

5.1 POTENTIAL ROUTES OF MIGRATION

Two potential source areas exist: the WWTPs and the landfills (see Figure 2). Potential contaminant release and transport media from these source areas include direct contact, volatilization and wind, erosion and runoff, surface water, and groundwater. Potential routes of exposure include direct contact, inhalation, dermal contact, and ingestion. The conceptual model illustrating the potential routes of constituent migration, routes of exposure, and receptors is illustrated in Figure 32.

5.1.1 Direct Contact

There is a potential for exposure to contaminants on the site via direct contact with WWTP liquid and sludge and leachate seeps from the landfills. Offsite exposure to sediments is also possible.

5.1.2 Volatilization and Wind

Constituents present in the WWTP liquid and sludge and in the landfills could be released through volatilization (organic compounds only) and/or wind erosion. Constituents volatilized or carried into the atmosphere as dust could be transported offsite. Constituents in the WWTP sludge or within the landfills could mobilize through volatilization and wind, if the sludge or landfills are excavated or similarly disturbed.

5.1.3 Erosion and Runoff

There is a topographic high at the landfills on the east side of the site. The western portion of the landfills and the WWTPs slope toward the Kaskaskia River to the west. The eastern portion of the landfills slope to the east toward the Embarras River. There is a potential for erosion resulting from runoff to mobilize constituents adsorbed onto soil and to transport these soils along surface water drainage features. However, runoff from the landfills is mitigated by the maintenance of a vegetated cover and is collected and routed to the facility's wastewater treatment facility. The WWTPs could potentially overflow, transporting contaminants.

5.1.4 Surface Water

Contaminants transported into surface water bodies can be volatilized, precipitate, or sorb into sediment. Contaminants in the sediment can dissolve and reenter the solution where they can potentially volatilize or migrate with suspended sediment when in a stream flow situation.

Surface water includes water in the drainage way along the landfills, the intermittent stream, the North Plant Lake, the Freshwater Lake, the WWTPs, and the Kaskaskia

River. Surface runoff has the potential to flow into adjacent surface water. In addition, groundwater that may contain contaminants could discharge into the surface water system.

5.1.5 Groundwater

Precipitation that percolates through the WWTPs and landfills and then enters the groundwater as recharge is the mechanism and pathway by which contaminants enter the groundwater system. Contaminants can migrate with groundwater from areas upgradient to areas downgradient.

Two principal groundwater pathways exist on the site. These include: the shallow glacial drift pathway (groundwater encountered within the upper glacial till) and the deep glacial drift pathway (groundwater encountered within the interglacial, middle glacial till, sand aquifer, and lower glacial till). The shallow glacial drift pathway is affected by the groundwater divide and mounding of the landfills on the east side of the site. Groundwater west of the divide flows west and discharges into Kaskaskia River. Groundwater east of the divide flows east into the Embarras River drainage system. Due to the mounding affect of the landfills, there is also some component of flow to the north of the landfills. The groundwater divide does not appear to extend to the deep glacial drift pathway. The flow in the deep glacial drift pathway is to the west toward the Kaskaskia River.

5.2 PHYSICAL AND CHEMICAL PROPERTIES OF CONTAMINANTS

The form, transport, and ultimate fate of potential contaminants is dependent upon such factors as temperature, soil moisture, oxidation-reduction potential, physiochemical properties of subsurface materials, water chemistry, and microorganisms present. Some characteristic properties of contaminants that influence their behavior are specific gravity, solubility, vapor pressure, diffusivity in air and water, organic carbon partition coefficient (K_{OC}), and octanol/water partition coefficient (K_{OW}).

The specific gravity of a constituent is referenced to water that has a specific gravity of 1.0. When present in sufficient quantities, constituents with a specific gravity greater than 1.0 will tend to sink or migrate downward through a saturated environment. These compounds are commonly referred to as dense nonaqueous phase liquids (DNAPLs). Likewise, when present in sufficient quantities, constituents with a specific gravity less than 1.0 will tend to float on top of water. These are referred to as light nonaqueous phase liquids (LNAPLs). As presented in Section 4.3, the constituent concentration levels found in the groundwater are in the part per billion range. These levels are not of sufficient quantity to indicate the presence of either DNAPLs or LNAPLS.

Solubility is the ability of a contaminant to dissolve in another liquid. Diffusivity refers to how readily the contaminant diffuses in different media. The higher the value, the faster the diffusion into the air or water. Solubility in water and diffusivity in water relate to each other in that the more soluble the contaminant, the more likely it will diffuse in water. Vapor pressure is a relative indicator of the tendency of a contaminant to transfer to the gas phase or to volatilize. For example, the higher the vapor pressure, the greater is the tendency to volatilize. Contaminants with high vapor pressure and high solubility will tend to dissolve rather than volatilize, if in contact with water. A more appropriate indication of a contaminant's tendency to volatilize or transfer from water to air is Henry's Law Constant. Henry's Law Constant takes into account molecular weight, solubility, and vapor pressure of a contaminant. Contaminants with Henry's Law Constants near 10^{-3} atmospheres cubic meter per mole (atm m^3/mol) will volatilize readily from water, while constants less than 10^{-5} atm m^3/mol will volatilize only to a limited extent. The octanol/water partition coefficient is a description of the chemical's hydrophobic quality. The carbon partition coefficient provides an indication of the tendency of a contaminant to adsorb to organic matter. Values of K_{oc} greater than 10^7 have the greatest adsorption potential; however, typical ranges are from 1 to 10^7. The first order degradation constant relates to how fast the chemical will degrade.

Three potential contaminant groups were found during RFI sampling of various media: VOCs, SVOCs, and inorganic analytes (including metals). Potential contaminants found above screening levels were selected for use in the contaminant migration pathway discussion. Physical and chemical data for the representative contaminants were obtained from the 35 Illinois Administration Code 742, Appendix C, Table E and *Illustrated Handbook of Physical-Chemical Properties and Environmental Fate and Transport for Organic Chemicals* (Mackay et al. 1992). The physical properties of the VOCs and SVOCs are listed in Tables 20 and 21, respectively.

5.2.1 Volatile Organic Compounds

Five (5) VOCs have been identified as potential concerns: acetone, benzene, cis-1,2-dichloroethene, ethylbenzene, and vinyl chloride. These five VOCs were chosen based on the review of the data presented in Section 4.0. Acetone and ethylbenzene were identified in the river sediments at concentration levels greater than screening levels. Benzene, cis-1,2-dichloroethene, and vinyl chloride were identified in the shallow groundwater in a single location (MW03S) at concentration levels greater than screening levels. These 3 VOCs were not detected in MW10, located near but downgradient of MW03S, suggesting that the extent of VOC groundwater impacts are limited and contained on site.

The physical properties of the five (5) VOCs are variable (see Table 20). Acetone is the most likely to dissolve in water rather than volatilize or sorb onto organic matter.

Benzene, cis-1,2-dichloroethene, ethylbenzene, and vinyl chloride are most likely to volatilize. Ethylbenzene exhibits the highest tendency of the five VOCs to sorb onto organic matter.

5.2.2 Semi-Volatile Organic Compounds

Sixteen (16) SVOCs have been identified as potential concerns:

2-Methylnaphthalene	Benzo(g,h,i)perylene	Indeno(1,2,3-cd)pyrene
Acenaphthene	Benzo(k)fluoranthene	Naphthalene
Acenaphthylene	Chrysene	Phenanthrene
Anthracene	Dibenzo(a,h)anthracene	Pyrene
Benzo(a)anthracene	Fluoranthene	
Benzo(a)pyrene	Fluorene	

These SVOCs were selected based on the review of the data presented in Section 4.0. They were identified in the river and/or intermittent stream sediments at concentration levels greater than screening levels.

The physical properties of these SVOCs are variable (see Table 21). PAHs are likely to sorb onto organic matter.

5.2.3 Inorganic Analytes

Thirteen (13) inorganic analytes (arsenic, boron, cadmium, chloride, chromium [total], copper, cyanide, iron, lead, manganese, nickel sulfate, and zinc) along with TDS have been identified as potential concerns. These inorganic analytes were chosen based on the review of the data presented in Section 4.0. Arsenic, cadmium, chromium (total), copper, cyanide, nickel, and zinc were identified above screening levels in the river and/or intermittent stream sediments. Boron, chloride, iron, lead, manganese, and sulfate, along with TDS were detected in the groundwater samples at concentrations above screening levels. These constituents' occurrence in groundwater may be partially attributed to the landfills.

The fate and transport of inorganic analytes is complex. Migration of inorganics is dependent upon the physical and chemical properties of the inorganic analytes, as well as those of the media of concern. Inorganic analytes may adsorb and desorb to oxides, organic matter, and mixtures of various reactive surfaces through ion exchange, oxidation-reduction reactions, and variations. Analytes with higher valency are most likely to bond with other ions first. Inorganic analytes may also precipitate or dissolve depending on the oxidation-reduction of the environment and the pH. A reducing environment will enhance metal precipitation; conversely, an oxidizing environment will cause metals to form oxides. Iron and arsenic are most susceptible to oxidation-reduction reactions.

5.3 CONTAMINANT MIGRATION CONCEPTUAL MODEL

The organic and inorganic potential contaminants of concern identified during the RFI have several potential migration pathways. The tendency for inorganics to migrate from the WWTPs and the landfills is more limited than organics. Migration of inorganics is limited, because the contaminants are likely to undergo reactions such as bonding with clay through adsorption or ion exchange or bonding with organic materials by complexing reactions. SVOC contaminants migrate more readily than inorganics; however, their relatively low solubilities inhibit their transport rate. VOC contaminants are typically the most mobile and have the potential to migrate as a liquid and a gas. Various migration pathways are possible; however, some are more probable based on the physical characteristics and analytical data collected during the RFI. The most pertinent pathways are direct contact, volatilization and wind, erosion and runoff, surface water, and groundwater. These migration pathways are discussed in the following sections.

5.3.1 Direct Contact Pathway

A direct contact pathway exists for onsite personnel or wildlife that come in contact with WWTP liquid or landfill leachate seeps. A direct contact pathway also exists to offsite persons or wildlife that come into contact with sediment associated with portions of the river or the intermittent stream extending from the area just west of the former Snake River impoundment.

Potential direct contact exposure to VOCs, SVOCs, and inorganics may occur through inhalation, ingestion, or dermal contact with WWTP contaminants. The potential onsite receptors for the direct contact pathway include trespassers, site workers, and terrestrial wildlife. The potential offsite receptors for the direct contact pathway include area residents, area farmers, and terrestrial wildlife that come into contact with liquid and/or soil associated with the river or the intermittent stream. People who consume exposed wildlife are secondary receptors.

The direct contact pathway for landfill source area media is limited by the controlled access to the landfill and the cap placed on the landfills during closure activities. Landfill refuse is not exposed at the surface. Security fences restrict unauthorized access to the landfill. Twenty-four-hour security limits access into the facility and the landfills. The WWTP area is enclosed by a security fence on the north, south, and east sides. Access is available through the gate to the Wastewater Treatment Plant from county road 615E or from the Kaskaskia River to the west. Restricted-area signs are posted on the entrance roads to all WWTPs, except high ponds 1 and 2, which are located across from the Wastewater Treatment Plant.

5.3.2 Volatilization and Wind Pathway

Contaminants present at or near the ground surface could be released through volatilization and/or wind erosion. The extent of volatilization is controlled by the concentration of contaminants, the contaminants' physical properties (i.e., Henry's Law Constant), wind, and temperature. The physical properties of the representative VOC and SVOC contaminants, such as Henry's Law Constant, are provided in Tables 20 and 21, respectively. The potential exposure route associated with volatilization and wind erosion is inhalation and dermal. Potential primary receptors for exposure include trespassers, current and future site users or workers, and persons downwind.

The landfills have the greatest potential for wind erosion, due to their height relative to the surroundings. The extent of wind erosion is dependent upon the wind direction and velocity, as well as ground surface conditions. The landfill cap and vegetation minimize the potential for release of contaminants through wind erosion.

5.3.3 Erosion and Runoff Intermediate Pathway

The erosion and runoff pathway consists of leachate seeps, surface water runoff, and sediment transport via surface flow of liquid with suspended sediment from the WWTPs and landfills. Erosion and runoff functions as an intermediate transport pathway of contaminants from the landfills to the drainage channels to the WWTP area. Run-off also discharges into the river and the intermittent stream to the offsite pond that eventually drains into the Kaskaskia River. The presence of the landfill cap and the vegetation on the landfill and across the area reduces the volume and slows the rate of erosion and runoff.

5.3.4 Surface Water Pathway

Surface water bodies may receive contaminants from the erosion and runoff intermediate pathway and from the groundwater intermediate pathway. Surface water pathways for contaminant migration are the WWTPs, the intermittent stream southwest of the site that ultimately flows into the Kaskaskia River, and the Kaskaskia River. Contaminants are transported in surface water through dissolution and suspension, and may be deposited in sediment or diluted and carried offsite.

Excluding the site, there are no drinking water intakes on the Kaskaskia River within 75 miles of the site. Accordingly, the primary receptors for any surface water are site workers, aquatic wildlife, and terrestrial wildlife. People who consume exposed wildlife are secondary receptors. People using the Kaskaskia River for recreation may come into dermal contact and/or ingest surface water. Sampling of the surface water shows that the quality of the surface water is similar downstream of the site as it is upstream.

5.3.5 Groundwater Pathway

The primary mechanism by which contaminants enter the groundwater system is water percolating through the WWTPs and the landfills into the underlying hydrostratigraphic units. Transport of contaminants in the groundwater pathway is via chemical and physical reactions (advection, diffusion, dispersion, dilution, solubility, adsorption, and degradation) and hydrostratigraphic controls.

Any contaminants dissolved in groundwater will be transported advectively with horizontal groundwater flow. Contaminant concentration in groundwater is reduced through dispersion and diffusion. Dispersion of contaminants is controlled by molecular diffusion and hydrodynamic (groundwater) mixing. Molecular diffusion significantly contributes to dispersion at very low groundwater flow velocities. Contaminants are dispersed throughout a hydrostratigraphic unit as groundwater velocity changes due to variations in lithology (hydrodynamic mixing). As groundwater velocities increase, so does dispersion. Dispersion can occur in longitudinal and transverse directions; however, longitudinal is more pronounced. Contaminant concentrations will be lower downgradient and at the margins in comparison to the source.

Solubility and adsorption are inversely related (see Section 5.2). Contaminants with low solubility are more likely to sorb onto organic carbon or inorganic minerals. Organic compounds will more likely sorb to soil with a high organic carbon content. Inorganic contaminants are most likely to undergo exchange reactions with clay minerals or ionic chemicals in water such as bicarbonate, sulfate, and chloride. Degradation of contaminants can occur through biological or natural means. Microbial, as well as chemical breakdown processes can reduce contaminants, enabling them to be susceptible to other chemical reactions.

The migration of contaminants is controlled not only by chemical reactions, but also by hydrostratigraphic characterization of the groundwater units. Such hydrostratigraphic controls include recharge and discharge boundaries, variation in lithologic units and thicknesses, gradient, geologic barriers, dimensions of the pathway, and the chemistry of the hydrostratigraphic unit. The two groundwater pathways each have specific hydrostratigraphic controls.

Several residential wells have been identified near the site. Many of these wells are set at a depth interpreted to be in the deep glacial drift pathway. The closest residential well appears to be located less than 700 feet northwest of the WWTPs. The well is located between the WWTPs and the Kaskaskia River, where groundwater flow is northwest towards the river.

The hydrogeologic characteristics and the migration of contaminants in the shallow glacial drift pathway and the deep glacial drift pathway are discussed and summarized in the following sections.

5.3.5.1 Shallow Glacial Drift Pathway

The shallow glacial drift pathway is found at the site within the upper glacial till deposits. RFI monitoring wells within this pathway include: MW02S, MW03S, MW04S, MW05S, MW08S, MW09S and MW10. This pathway is not used as a source for potable water and is classified as Class II groundwater. As discussed previously, a groundwater divide on the east side of the site affects the flow of groundwater in this pathway. Groundwater flows from the landfills to the west and discharges into the Kaskaskia River. Groundwater flow on the east side of the landfill areas flow east to the Embarras River drainage basin. Based on groundwater elevation data obtained from the existing landfill monitoring wells, groundwater flow also appears to be to the north in the immediate areas north of the landfills.

The potential contaminants of concern associated with the shallow glacial drift pathway include VOCs (found at MW03S only) and inorganics.

Monitoring well MW03S was the only well in the shallow glacial drift pathway to detect potential VOCs of concern. Benzene, cis-1,2-dichloroethene, and vinyl chloride were detected at concentrations above screening levels. Based on groundwater and surface water elevation data, the groundwater at MW03S appears to flow to the southwest. No VOCs were detected in monitoring well MW10 which was installed into the shallow glacial drift pathway approximately 200 feet southwest of MW03S and approximately 200 feet north of the facility's south property line.

No SVOCs were detected in any of the groundwater samples collected from the shallow glacial drift pathway at concentrations above Class II screening levels. However, a number of PAHs were detected in the sample collected from MW04S during the March 2001 sampling event. The concentrations of the PAHs were below their respective Class II screening levels. A drainage channel containing stormwater runoff and wastewater from high ponds 19 and 20 is located approximately 50 feet northeast and north of MW04S. The groundwater at this location flows in a southwest direction toward the Freshwater Lake. Based on groundwater flow, groundwater elevation data, and the elevation of the water in the drainage channel, it appears that the storm water runoff and wastewater from the drainage channel may be impacting MW04S.

The potential inorganic contaminants of concern identified in the shallow glacial drift pathway include iron and sulfate. Iron was detected above screening levels in four shallow RFI monitoring wells. It was above screening levels in MW02S during the March and August 2001 sampling events; in MW03S during all three (3) sampling events; in MW04S during the August 2001 sampling event only; and in MW09S during the December 2000 sampling event only. Sulfate was detected in three of the monitoring wells located near the WWTP area. It was above screening levels in MW03S during the December 2000 and August 2001 sampling events; in MW04S during the March and August 2001 sampling events; and in MW05S during all three (3) sampling events. In addition, higher concentrations of iron and sulfate have been found in the shallow monitoring wells associated with the landfill groundwater-monitoring program. Iron and sulfate are often associated with gypsum and fly ash. Therefore, the detection of these inorganic constituents are most likely related to the landfills on the site. The monitoring of the groundwater associated with the landfills is currently being managed as part of the landfill closure permit, administered by the Illinois EPA.

Chloride and lead were identified above Class II groundwater screening levels at isolated locations. Chloride was detected in RFI monitor well MW03S and in landfill monitoring wells G110 and G113/R113. Lead has been detected in landfill monitoring well G112. These occurrences may be attributable to the facility, but are isolated and insignificant compared to the other contaminants detected.

5.3.5.2 Deep Glacial Drift Pathway

The deep glacial drift pathway is found at the site within the interglacial, middle glacial till, sand aquifer, and the lower glacial till. RFI monitoring wells within this pathway include: MW01D, MW01S, MW02D, MW03D, MW04D, MW05D, MW06D, MW06S, MW07D, MW07S, MW08D, MW09D, and MW11. Groundwater within this pathway is used as a source of potable water by offsite receptors and is classified as Class I groundwater.

The only VOCs detected in groundwater samples collected from the deep glacial drift pathway included chloroform and bromodichloromethane. As discussed in Section 4.3, these constituents are not associated with the groundwater but were introduced during the completion of the soil borings for the installation of the monitoring wells.

SVOCs were detected in the August 2001 groundwater sample collected from monitoring well MW01S. As discussed in Section 4.3, these constituents are not associated with the groundwater but are the result of cross-contamination from vapors coming from the recent road oiling of the county road beside MW01S.

Inorganic concentrations above Class I screening levels in the deep glacial drift pathway include iron, manganese, and sulfate. Iron was detected above screening levels in nine (9) deep monitoring wells. It was above screening levels in MW06D, MW07D, and

MW07S during all three (3) sampling events; in MW03D, MW04D, and MW05D during the March 2001 sampling event only; in MW01S during the August 2001 sampling event only; in MW06S during the December 2000 and August 2001 sampling events; and in MW08D in the December 2000 sampling event only.

Manganese was detected above screening levels in nine monitoring wells. It was above screening levels in MW06S and MW07S during all three (3) sampling events; in MW01S during the March and August 2001 sampling events; in MW03D, MW05D, MW07D, and MW08D during the December 2000 sampling event only; in MW04D during the March 2001 sampling event only; and in MW11 (installed July 2001) during the August 2001 sampling event.

Sulfate was detected above screening levels in only monitoring well MW01S during the March and August 2001 sampling events.

As previously discussed in Section 5.3.5.1, higher concentrations of iron and sulfate have been found in the monitoring wells associated with the landfill groundwater monitoring program. Manganese is believed to be related to the landfills on the site. The monitoring of the groundwater associated with the landfills is currently being managed as part of the Illinois EPA landfill closure permit.

As discussed in Section 4.3, boron was not detected above its groundwater screening level in groundwater collected from any of the RFI monitoring wells. However, it has been detected in groundwater collected from some of the landfill monitoring wells. Boron was detected in all of the deep RFI monitoring wells (including MW08D, which is upgradient of the facility) at concentration levels at or above 1,000 µg/L. The higher boron levels appear to be a regional issue. However, boron is also sometimes found as a component of fly ash. Therefore, the boron found in some of the landfill monitoring wells may be partially attributable to the closed landfills.

Lead was identified above Class I groundwater screening levels at: MW04D, March 2001 sampling event only; and MW06S, August 2001 sampling event only. These isolated, one-time occurrences, are insignificant compared to the other contaminants detected.

6.0 FINDINGS AND CONCLUSIONS

The purpose of this RFI was to identify the nature and extent of releases of hazardous waste and/or hazardous constituents from SWMUS or AOCs at the facility that may pose an unacceptable risk to human health or the environment. The RFI follows USEPA's 1988 RFA identifying SWMUs and AOCs at the site. Field and researched data were collected and analyzed to complete this task. The data was evaluated to determine the present and potential impacts to the area from the site.

6.1 FINDINGS

The geology of the site was characterized from RFI soil borings, existing landfill monitoring well borings, RFI geotechnical results, geologic cross sections, and interpreted from maps and geological literature. The site geology consists of Pre-Illinoian, Illinoian, Sangamonian, and Wisconsinan stage glacial drift deposits. Five lithologic units were determined from the RFI soil borings: an upper glacial till, an interglacial layer, a middle glacial till, a sand aquifer, and a lower glacial till. The upper glacial till was deposited during the Wisconsinan Stage and consists of light brown to gray silty clay with some sand and gravel. The interglacial layer was deposited during the Wisconsinan and Sangamonian Stage and is characterized by silts, organic silts, sand, and peat. The middle glacial till consists of Illinoian stage gray silty clays and clayey silts with lenses of sand and gravel. Underlying the middle glacial till is a sand aquifer deposited during the Illinoian Stage. This layer is characterized by alternating layers of poorly sorted and well sorted sand. Below the sand aquifer layer lies the lower till deposited during the Illinoian Stage. This glacial till consists of gray silty clays with low moisture.

The hydrogeology of the study area is divided into two hydrostratigraphic units: the shallow glacial drift pathway, and the deep glacial drift pathway. The shallow glacial drift pathway is defined as groundwater found within the upper glacial till. The deep glacial drift pathway is defined as groundwater within the interglacial, middle glacial till, sand aquifer, and lower glacial till. Groundwater within the shallow glacial drift pathway is classified as Class II groundwater, while groundwater within the deep glacial drift pathway is considered Class I groundwater.

RFI monitoring wells MW02S, MW03S, MW04S, MW05S, MW08S, MW09S, and MW10 are completed in the shallow glacial drift pathway; and RFI monitoring wells MW01D, MW01S, MW02D, MW03D, MW04D, MW05D, MW06D, MW06S, MW07D, MW07S, MW08D, MW09D, and MW11 are completed in the deep glacial drift pathway. The average hydraulic conductivity of the shallow glacial drift pathway is 1.03E-03 cm/sec, and the geometric mean is 6.93E-05 cm/sec. The average hydraulic conductivity of the deep glacial drift pathway is 7.56E-02 cm/sec, and the geometric mean is 8.95E-03 cm/sec.

The shallow glacial drift pathway is affected by a north-south trending groundwater divide located on the east side of the site at the landfills. Groundwater west of the divide flows west and discharges into the Kaskaskia River. Groundwater east of the divide flows east into the Embarras River drainage system. Due to the mounding affect of the landfills, there is also some component of flow to the north of the landfills. The groundwater divide does not appear to extend to the deep glacial drift pathway. The flow in the deep glacial drift pathway is to the west toward the Kaskaskia River.

The results of the ecological inventory conducted on Kaskaskia River, the site, and the surrounding area indicate that a diverse group of aquatic life including fish, amphibians, waterfowl, mollusks, macroinvertebrates, and aquatic animals is found in the Kaskaskia

River. The portions of the Kaskaskia River within the study area appear to be in good condition and not affected by the site. The Illinois DNR has identified the Kaskaskia River from U.S. Highway 36 (which borders the site to the south) and extending 7.5 miles north upstream (identified as the Kaskaskia River-Chicken Bristle area) as a natural area due to the high mussel diversity within that region. One Illinois endangered mussel (*Villosa lienosa,* Little spectaclecase) and one Illinois threatened mussel species (*Uniomerus tertalasmus*, Pondhorn) have been identified by the Illinois DNR.

A wetland delineation indicated that four wetland types were located within the study area. The Kaskaskia River, the WWTPs, drainage swales, the Freshwater Lake, and the North Plant Lake compose part of these wetlands. The wetlands located on the site and adjacent to the Kaskaskia River appear to be in good condition based on the diversity of flora and fauna, with no observable signs of deteriorated or stressed ecosystems. The delineation did not address whether the wetland areas are within the jurisdiction of the Clean Water Act.

A total of 40 potable wells have been identified within a 2-mile radius of the center of the site. The nearest residential well appear to be located less than 700 feet northwest of the site. Most residents near the site appear to be supplied with water from private wells. Most of these wells have been completed at depths of 100 feet or less and appear to be screened in the same sand aquifer screened by the deep RFI monitoring wells.

- The results of the analytical data obtained from the WWTP sludge, Kaskaskia River surface water and sediment, intermittent stream sediment, and the groundwater samples collected from the RFI monitoring wells were compared to screening levels specified by various regulatory bodies intended to be protective of either human health or ecological receptors (flora and non-human fauna). A detection of a contaminant above a screening level does not indicate a risk to human health or the environment. It only indicates the need for additional analyses. The results are summarized below:

- *WWTP Sludge Sampling*: Four VOCs, six SVOCs, and three metals were identified in the analyses of the WWTP source media, specifically the sludge, as potential contaminants of concern. Three VOCs (ethylbenzene, toluene, and tetrachloroethene) exceeded screening levels only in the high ponds, while benzene exceeded screening levels in the high, middle, and low ponds. Three SVOCs (benzo[a]anthracene, benzo[a]pyrene, and benzo[b]fluoranthene) were detected above screening levels in all of the ponds. Two SVOCs (dibenzo[a,h]anthracene and indeno[1,2,3-cd]pyrene) were detected over screening levels in the high and middle ponds. One SVOC (naphthalene) was detected above screening levels in the high ponds only. Three metals (arsenic, beryllium, and total chromium) were found above their respective screening levels throughout all of the ponds. The benzene and metals concentrations progressively decreased from the high to the low ponds.

- *Kaskaskia River Surface Water Sampling*: No contaminants exceed any human health based screening levels for surface water. However, two (2) SVOCs (anthracene and pyrene) exceeding ecological screening levels were detected in a water sample collected from the Kaskaskia River at the railroad bridge downstream of the facility. These contaminants are commonly associated with the preservatives in railroad ties; and therefore, may be attributable to leaching of the contaminants from the ties into the river. Furthermore, these contaminants were not detected in any of the surface water samples collected upstream of this location including the sample collected between the bridge and the facility and the sample collected from the wastewater treatment ponds outlet channel. Therefore, these contaminants are not considered as surface water contaminants of concern attributable to the facility.

- *Kaskaskia River and inlet/outlet channel Sediment Sampling*: Two (2) VOCs (acetone and ethylbenzene), PAHs, and six (6) metals (arsenic, cadmium, chromium, copper, nickel, and zinc) have been identified as potential contaminants of concern in sediment samples collected from the facility outlet channel (SS06A – E) and downstream of the facility (SS04A – J) due to concentrations exceeding ecological screening levels.

- *Intermittent Stream Sediment Sampling*: The PAHs, four (4) metals (arsenic, chromium, copper, and nickel), and cyanide have been identified as potential contaminants of concern in onsite sediment samples collected from the intermittent stream (SS01 and SS02) due to concentrations exceeding ecological screening levels. These contaminants were not detected in the sediment sample collected from the offsite pond (SS03). Furthermore, the detected levels of these contaminants appear to progressively decrease in concentration downstream of the head of the intermittent stream.

- *VOCs in Groundwater Sampling*: The shallow glacial drift pathway is identified as Class II groundwater, and the deep glacial drift pathway is classified as Class I groundwater (as discussed above). Three (3) VOCs (benzene, cis-1,2-dichloroethene, and vinyl chloride) were detected above Class II groundwater screening levels at a single location (MW03S) in the shallow glacial drift pathway. Thus, the 3 VOCs were identified as potential contaminants of concern. None of these VOCs were detected in the remaining RFI samples in the deep glacial drift pathway or above Class II screening levels in the shallow glacial drift pathway. In addition, none of the VOCs were detected in MW10, which is screened in the shallow glacial drift pathway, only about 200 feet southwest of MW03S. This indicates the VOC impacts at MW03S are of limited extent and confined to the site. Chloroform, originally detected in several of the groundwater samples from the deep glacial drift pathway, was introduced by drilling water during the completion of the soil borings for the installation of the monitoring wells and is not a contaminant of concern.

- *SVOCs in Groundwater Sampling*: The only SVOCs detected in the RFI groundwater analyses were the PAHs in a groundwater sample collected from MW04S during the March 2001 sampling event, and the PAHs in a groundwater sample collected from MW01S during the August 2001 sampling event. The concentrations of the PAHs detected in MW04S were below their respective Class II screening levels. The PAHs detected in MW01S are the likely result of cross-contamination from vapors coming from the recent road oiling of the county road beside MW01S.

- *Metals in Groundwater Sampling*: Four metals (boron, iron, lead, and manganese) were identified as potential contaminants of concern in the groundwater. None of the groundwater analyses conducted during the RFI detected boron above its Class I or Class II screening levels in the shallow or deep glacial drift pathways. However, boron historically has been detected in the onsite landfill monitoring wells, which are in the shallow glacial drift pathway, at concentrations above Class II screening levels. Iron was detected in the shallow glacial drift pathway above its Class II screening level and in only three (3) RFI monitoring wells screened in the deep glacial drift pathway on a repeatable basis above its Class I screening levels in the RFI analyses. Lead was only detected in two RFI monitoring wells (MW04D – March 2001 sampling event and MW06S – August 2001 sampling event) within the deep glacial drift pathway above its Class I screening level. No lead concentrations were detected in the shallow glacial drift pathway above Class II screening levels in any of the RFI groundwater analyses. Historically, iron and lead have also been identified above their respective Class II screening levels in the onsite landfill monitoring wells located in the shallow glacial drift pathway. Manganese was detected in only four (4) RFI monitoring wells within the deep glacial drift pathway on a repeatable basis above its Class I groundwater screening level. However, it was not detected in any RFI groundwater analyses from the shallow glacial drift pathway above the Class II groundwater screening level. The concentrations of boron, iron, lead, and manganese detected in the deep glacial drift pathway appear to be consistent with regional concentration levels based on the results of the potable water well sampling. Therefore, these metals have been identified as potential contaminants of concern with respect to the shallow glacial drift pathway, which is not used for human consumption.

- *Other Inorganics in Groundwater Sampling*: The groundwater also contains three inorganic analytes (chloride, sulfate, and total dissolved solids [TDS]) identified as potential contaminants of concern. Chloride was detected in the shallow glacial drift pathway at concentrations above its Class II screening level in only one RFI well (MW03S) during the RFI sampling events. Historically, it has also been detected in existing landfill monitoring wells within the shallow glacial drift pathway above its Class II screening level. Sulfate was found in the shallow glacial drift pathways, during the RFI, at concentrations above its Class II screening level. Historically, sulfate has also been detected in several of the existing landfill monitoring wells within the shallow glacial drift pathway above its Class II screening levels. Sulfate was also found at concentrations above its Class I screening level in one (1) RFI monitoring well (MW01S) screened in the deep glacial drift pathway. Sulfate was not detected above its Class I screening level in any of the potable water well samples. No screening levels exist for TDS; however, concentrations of TDS in the shallow glacial drift pathway, identified in the RFI, exceed the Groundwater Quality Standard (GQS) in 35 Illinois Administrative Code (IAC) Part 620. Historically, TDS has also exceeded the Groundwater Quality Standard in the landfill monitoring wells in the shallow glacial drift pathway. TDS was also detected at concentrations above its GQS in one (1) RFI monitoring well (MW09D) during only one (1) of the three (3) sampling events. Therefore, these other inorganics have been identified as potential contaminants of concern with respect to the shallow glacial drift pathway, which is not used for human consumption.

6.2 CONCLUSIONS

Based on the data collected during the RFI activities, the following conclusions have been made:

- The nature of the WWTP source media, specifically the sludge, has been characterized. The characterization has identified 13 potential contaminants of concern in the sludge. The contaminants include four VOCs, six SVOCs, and three metals.

- It is unlikely that site operations have impacted the Kaskaskia River surface water or the ecology and wetlands associated with it.

- The sediment samples from the river and the intermittent stream originating in the southwest area of the facility contain VOCs, SVOCs, and metals above screening levels. The concentration levels found in the impacted areas do not warrant interim corrective action. The need for corrective action will be evaluated during the Corrective Measures Study.

- Activities from the facility do not appear to have impacted the groundwater within the deep glacial drift pathway.

- Impacts to groundwater within the shallow glacial drift pathway center around the area of the wastewater treatment plant (MW03S) and the landfills. No contaminants of concern are present in monitoring well MW10 (located approximately 200 feet southwest of MW03S). Therefore, the impacts appear to be localized and contained on site. The need for corrective action in this area will be evaluated during the Corrective Measures Study. The impacts associated with the landfills are already being addressed as part of the Illinois EPA post-closure permit. The Illinois EPA has required a landfill groundwater assessment monitoring program, which the facility is implementing. This assessment program will determine if corrective action is needed with respect to the groundwater impacts from the landfill.

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8.0 LICENSED PROFESSIONAL GEOLOGIST CERTIFICATION

I hereby attest that the geologic portions of this report developed specifically by Clayton Group Services, Inc. were conducted by me or under my direction, supervision, and/or review and to the best of my knowledge and belief have been prepared and administered in accordance with the standards of reasonable professional skill and diligence.

Geologist Name: Monte Nienkerk

Company: Clayton Group Services, Inc.

Phone: 630.795.3200

Registration Number: 196-000322

License Expiration Date: 3/31/2003

Signature: Monte M. Nienkerk

LICENSED PROFESSIONAL GEOLOGIST
MONTE M. NIENKERK
#196-000322
ILLINOIS